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SCRANTON, PA.

VOLUME VI

ELECTROTHERAPY

PHYSICS OF LIGHT AND CAUTERY

ELECTRICITY IN DISEASES OF THE EYE, EAR, NOSE, AND THROAT

ELECTRICITY IN GENITO-URINARY DISEASES

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ELECTRIC HEATING

1. Loss of Electromotive Force.—The phenomena connected with the passage of electric currents through conductors have been treated fully in Volume 1 of this Course. Among the phenomena considered were those relating to chemical decomposition, electromagnetism, induction, and, finally, mechanical effects, as in electric motors.

In every instance, when work was performed in some form or other, the current lost part of its energy by losing part of its electromotive force. In other instances, when no visible work was performed, a certain part of its energy was lost in overcoming the resistance of the electric circuit. An instance of this kind is found in voltaic batteries, where the internal resistance often equals that of the whole external circuit. In this connection it will be remembered that the rule was given in Art. **134,** *Direct Currents*, that "a maximum current is sent through a given external resistance, when the resistance of the battery is equal to the external resistance." It seems that here, and in other similar combinations, a great waste of energy must be going on, and the question naturally suggests itself: What becomes of this electric energy, which apparently disappears without leaving any visible traces behind?

2. Transformation of Energy.—As energy cannot be lost, it must, if disappearing in one form, reappear in some other form, and though the new form in which it reappears is not perhaps at once traceable, it is, nevertheless, present and will be found on closer investigation.

It is a fact proved by numerous experiments, that whenever a resistance is placed in the path of an electric current, it can overcome the resistance only by giving up part of its energy to the material of said resistance, and that the energy then reappears in the form of heat. As this heating property of the electric current is made use of in cauteries and electric lamps it is important to find the relations between the electrie energy expended and the heat developed, when various forms and kinds of conductors are used.

3. Variation in Heating Effects.—In order to fully grasp this subject it is necessary briefly to mention a few facts relating to heat and its effects on different substances. If we take a piece of copper and hold it over the flame of a Bunsen burner for a certain specified time and then measure its temperature, we will find that the latter is very different from the temperature gained by a similar piece of platinum exposed to the same heat and for the same length of time. The latter will show a temperature about three times higher than that of the former. A still greater difference is found if a piece of carbon is heated. Continuing our experiments, we will soon ascertain that metals, fluids, etc. all show a difference in their ability to receive heat from some source or other.

SPECIFIC HEAT

4. We may briefly explain this by supposing that each molecule of matter requires the same amount of heat to raise its temperature a certain number of degrees. The lighter the molecules of which a body is made up the more of them there must be to make up a certain mass. And, further, the greater the amount of molecules a body contains the more heat it will require to raise its temperature. Bodies of higher specific gravity contain a smaller number of molecules in a given mass, because each molecule weighs more. There being fewer molecules to heat, it will require less heat to raise the temperature of the whole mass. We see, then, that there is a close relation between the *thermal capacity* or *specific heat* of a body and its *specific gravity*.

5. Unit of Heat.—It is too indefinite to say that more heat is required to raise the temperature of one piece of metal than that of another piece, and some unit must therefore be adopted to enable us to make a comparison between various quantities of heat. For this purpose that quantity of heat has been selected which is able to raise the temperature of 1 cubic centimeter of water, that is 1 gram, from 3° to 4° C. This unit has been named 1 *calorie.* Five calories will therefore be able to raise the temperature of 1 gram of water 5° C., or 5 grams of water 1° C., and, similarly, any other combination of grams and calories, the product of which will be equal to 5 calories.

6. Table of Specific Heats and Gravities.—In the table below are given the specific heats and specific gravities for various substances. Water is there taken as unity, meaning that if it will take 1 calorie to raise the temperature of 1 cubic centimeter of water 1° C., it will require a fractional part of 1 calorie to raise the temperature of any of the other substances there named to the same height. For instance, lead would require only .0314 calorie, etc.

TABLE I

Substances	Specific Heat	Specific Gravity
Lead	.0314	11.4
Platinum . . .	.0324	22.1
Silver	.0611	10.5
Copper . . .	.1013	8.9
Zinc	.1015	6.9
Iron . . .	.1218	7.8
Graphite . .	.2018	1.6
Water .	1.0000	1.0

7. Relations Between Specific Heat and Specific Gravity.—There is some similarity between thermal and electrostatic capacity. If the latter is small, it requires a small electric charge to raise the pressure to that of 1 volt; and,

similarly, if the thermal capacity or specific heat is small, it takes a small amount of heat to raise the temperature 1° C.

In general, it is found that with an increase in specific gravity there follows a decrease of specific heat. Lead and iron are exceptions to this general rule.

An examination of the values given for specific heat will show that it takes twice as much heat to raise 1 pound of silver to the same temperature as that of 1 pound of platinum, and nearly 4 times more heat to raise iron to the same temperature as that of lead. If, for instance, two rods, one of silver and one of platinum, were held together over a Bunsen burner, it would shortly be found that the platinum rod was red hot, while the silver rod would be comparatively cool.

8. The Joule, Watt, and Calorie.—Having now ascertained the meaning of specific heat and a calorie, the relations between the calorie and electrical work have to be found. It was just stated that while an electric current was passing through a conductor the resistance of the latter had the effect of changing part of the electric energy into heat. Heat must, therefore, simply be another form of electric energy, and, as it was possible to express the energy of the electric current in foot-pounds, it should likewise be possible to express the energy of heat in the same unit.

The unit of electrical work is the *joule*, which was found to equal .7373 foot-pound. (See Art. **15**, *Direct Currents.*) It has been found that

1 calorie = 4.2 joules = 3.07 foot-pounds.
1 joule = .24 calorie = .7373 foot-pounds.

As 1 watt = 1 joule per second and 1 joule = .24 calorie, it follows that 1 watt = .24 calorie per second.

9. Heat Developed in a Conductor Proportional to Square of Current-Strength.—In Art. **20**, *Direct Currents*, the following formulas for finding the number of watts developed were given:

$$W = E \times C = \frac{E^2}{R} = C^2 R.$$

The last of these only will be used in finding the relation between the current passing through a conductor and the heat developed in it.

This formula $W = C^2 \times R$ shows that when heat is produced in an electric conductor, it is not proportional simply to the number of amperes passing, but to the square of the same. If, for instance, 2 amperes is flowing and transformed into heat, 4 amperes will not simply double the quantity of heat developed, but will increase it 4 times. Why this increase should be proportional to the *square* of the current-strength may not seem quite clear, and a practical example may help to make the matter better understood. When chemical energy is transformed into electrical energy, as, for instance, in a voltaic cell, the amount of material consumed per hour is proportional to the strength of the current. Suppose six Daniell cells are connected in series and are sending a current of 1 ampere through an external resistance. As the consumption of zinc per cell amounts to .043 ounce per ampere for each hour, the total amount of zinc consumed amounts to $6 \times .043 = .258$ ounce. If it is desirable to increase the current-strength to 2 amperes, while the resistance remains constant, then the E. M. F. must be doubled and therefore the number of cells increased to 12. As now each cell is transmitting a current of 2 amperes, twice the amount of zinc must be consumed, or .086 ounce per cell, and the number of cells now being 12, the total amount of zinc consumed is $12 \times .086 = 1.032$ ounces. This is 4 times .258 ounce, the original amount. We see then that to double the current-strength, 4 times as much chemical or electrical energy had to be developed, the electrical energy being proportional to the amount of material chemically transformed.

10. Conclusions.—From these considerations we come to the conclusion that the greater the number of watts transformed into heat the more rapidly the temperature must rise. Contrarily, the higher the specific heat of a conductor, or its capacity for heat, the more slowly will this rise take place, and, finally, the greater the mass or weight of the conductor the more time will be required to effect a rise in temperature.

CONDUCTION, CONVECTION, AND RADIATION

11. The increase in temperature of a conductor does not, as a rule, keep step with the number of watts spent in heating it, because heat, like electricity, is subject to losses from various causes. These losses may take place in three different forms, through conduction, convection, and radiation.

In *conduction*, the heat is transmitted from particle to particle in the body itself. In a heated electric conductor the heat would leak from the interior to the surface.

The transmission of heat by *convection* takes place in liquids and gases only, as it requires a certain mobility of the molecules of the substance. If a beaker of water is placed over a Bunsen burner, the bottom will become heated and the particles of water situated immediately above the same will be heated by conduction. When heated they become lighter and rise to the surface, thereby giving room to other particles. In this manner a constant stream of water will carry off the heat supplied by the bottom of the vessel.

When *radiation* goes on there is no direct contact between the source of the heat and the recipient of the same. The ether is in this case the transmitting medium and is able to transfer the heat from one place to another without itself being heated. For instance, the sun radiates its heat through space and in this manner supplies the earth with its necessary heat, but without heating the intervening medium.

12. Limit to Increase of Temperature.—A heated conductor may give up its heat by either one or all of these forms. If exposed to the air, the latter will become heated and, in passing away, set up a current that will constantly carry off heat from the conductor. The amount of surface a conductor exposes to the air will therefore be of importance in determining the rise in temperature. Thin wires heat more rapidly than thick wires of the same material, partly because they have less surface to dispose of the heat and partly because of the higher resistance. Suppose, for instance, that two wires, one $\frac{1}{32}$ and the other $\frac{1}{64}$ inch in diameter, have to carry the same current. The

thinner wire will have a cross-sectional area $\frac{1}{4}$ that of the thicker; therefore, it has 4 times greater resistance and 4 times more heat units developed in it. But, as these heat units act on a mass 4 times smaller than that of the larger wire, there will be an increase in temperature 16 times greater in the smaller wire. Then again, it must be remembered that the smaller wire has a surface only one-half that of the larger wire, and consequently it will have more difficulty in getting rid of the surplus heat. As the thin wire grows hotter it will also increase in resistance, and its temperature will continue to rise until it has reached a point where there is a balance between the heat received and that given off by conduction and radiation.

13. Effect of Length.—If the resistance of a long conductor is the same as that of a short conductor with the same diameter, the number of heat units developed in both should be the same. But the increase in temperature of the long conductor may be hardly noticeable, partly because the heat has to be distributed over a larger mass and also because the longer wire has a greater radiating surface.

14. Effect of Heat on Resistance.—As already stated, the resistance of a metallic conductor increases with the temperature. The amount of this increase is about .38 per cent. per degree centigrade for pure metals. For instance, if a copper conductor has a resistance of 220 ohms and its temperature is raised 100° C., its resistance will increase to about 304 ohms. In general, it may be said that conductors *increase* and insulators *decrease* in resistance, when heated.

Certain metallic alloys used for high-resistance coils suffer a very small increase in resistance when heated, and some of them, notably manganin, actually decrease in resistance. Carbon and india-rubber decrease in resistance when warm, the latter very much so, even with a small increase in temperature. The increase in conductivity of carbon amounts to about .03 per cent. per degree centigrade. For instance, if the carbon filament of an incandescent lamp has 220 ohm's resistance, it will be reduced to 213 ohms at an increase in temperature

of 100° C., and to 135 ohms at an increase of 1,280° C., which is the usual difference in temperature between hot and cold.

Liquids decrease in resistance by an increase in temperature. Water, when absolutely pure, does not conduct, but when mixed with gases or saline bodies, it is able to act as a conductor and its resistance will then depend on the resistance and quantity of these foreign substances. If 8 per cent. of sulfuric acid is added to the water, the resistance will decrease .65 per cent. per degree centigrade, so that a column of water with 1,000° ohm's resistance will, when the temperature is increased 100° C., have its resistance reduced to 350 ohms.

15. Different Temperatures in One Conductor. If part of a heated conductor, such as a cautery, be either cooled or heated, it will influence the total resistance of the circuit and increase or decrease the current-strength. Suppose, for instance, that a glowing cautery is brought in contact with living tissue. Part of it will then be cooled off, its resistance will be lowered, and the amperage will be increased. Consequently, the parts unaffected by the tissue will grow hotter. On the contrary, if the same part of a conductor has heat imparted to it, its resistance is increased, the current is reduced in strength, and the adjoining parts grow cooler. In the first instance, the outlying parts of the cautery may grow so hot as to fuse, therefore the importance of providing means, such as a rheostat, for regulating the current-strength through an active cautery.

16. Importance of Low Resistance in a Cautery Circuit.—As the cautery itself is of a very low resistance, it follows, as a consequence, that if a large amount of heat shall be developed in it, a current of high amperage is required. Under these circumstances a heavy current will naturally have to pass through the whole circuit, inclusive of the battery itself, and, if no heat shall be developed anywhere but in the cautery, it follows that the other parts of the circuit must have a resistance much lower than that of the cautery. If this is not the case, heat will also be developed in places where it is

not desired, and where it would either be inconvenient to the patient or to the operator, besides being a useless waste of power.

For instance, if the cautery holders or the conductors leading to the latter are too small in diameter, then they are liable to get heated and in this manner will not alone waste heat, but will also, by their increase in resistance, reduce the current-strength and prevent the cautery from receiving its full quota of the total energy at disposal. A few examples will show the importance of this point.

A battery *B*, Fig. 1, producing an electromotive force of 4 volts and with an internal resistance of .02 ohm, is to supply the current to a cautery *C* of .035 ohm's resistance, and it is desirable to find the effect that the resistance of the conductors *W* between the cautery and battery will have on the current-strength of the latter. It is supposed that 20 amperes are

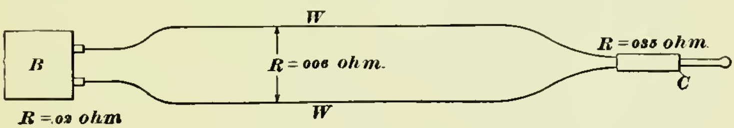

FIG. 1

required to heat the cautery and that two conducting-cords, of a joint resistance of .006 ohm, connect the battery and cautery. The total resistance of the circuit is, then, $.02 + .006 + .035 = .061$ ohm. If no rheostat is in the circuit, the current-strength $C = \frac{E}{R} = \frac{4}{.061} = 65.6$ amperes. To reduce this current to 20 amperes, a rheostat is installed and a resistance of .139 ohm is inserted so as to make the total resistance .2 ohm. By means of the rheostat this supplementary resistance may be increased or diminished as the circumstances may require. This extra resistance of .139 ohm corresponds to a loss in voltage of 2.78 volts, which is changed into heat in the rheostat.

If these conducting-cords of .006 ohm's resistance are replaced by some of .12 ohm's total resistance, the resistance of the whole circuit will be $.02 + .12 + .035 = .175$ ohm, and the maximum current-strength is $C = \frac{4}{.175} = 22.9$ amperes. There

is now a surplus resistance of .2 — .175 = .025 ohm, only, which represents a loss in voltage of 20 amperes × .025 ohm = .5 volt, which is a very small margin when it is considered that the heating of the circuit will increase the resistance materially and that a bad connection somewhere may consume this surplus. If the whole resistance of the rheostat were switched out, it would in this case have little or no compensating effect on the increased resistance of the circuit. The influence of the two conductors will be more clearly shown in the following table:

TABLE II

	Conductor of .006 Ohm's Resistance	Conductor of .12 Ohm's Resistance
Resistance of cautery	.035 ohm	.035 ohm
Resistance of circuit exclusive of rheostat	.061 ohm	.175 ohm
Resistance of circuit inclusive of rheostat	.200 ohm	.200 ohm
Surplus resistance in rheostat	.139 ohm	.025 ohm
Surplus voltage consumed in rheostat	2.780 volts	.500 volt
Current in the circuit with rheostat	20.000 amperes	20.000 amperes
Percentage of total pressure lost in conducting-wires	3.0	60.0
Percentage lost in cautery	17.5	17.5
Percentage lost in battery	10.0	10.0
Percentage lost in rheostat	69.5	12.5

17. Cautery Battery of Low Resistance.—When it is so important to reduce the resistance of the conductors to a minimum, it can easily be seen that the resistance of the battery must also be as small as possible. Suppose, for instance, that the attempt should be made to run the above cautery by means of two Leclanché cells, each with an E. M. F. of 1.7 volts and internal resistance of .8 ohm. Arranging the cells in series, their joint pressure will be 3.4 volts and their resistance 1.6 ohms; adding to this the resistance of the conducting-cords and the cautery, the total resistance will be 1.6 + .006 + .035 = 1.641 ohms.

Therefore, $C = \frac{3.4}{1.641} = 2.072$ amperes, instead of the 20 amperes required. As it was shown in Art. **138**, *Direct Currents*, that an increase in the number of cells in series with a small external resistance does not increase the current-strength, it is useless to add any more cells. The only possible improvement would be to connect the cells in parallel. Then the total pressure would be that of one cell, or 1.7 volts, and their joint resistance $\frac{.8}{2} = .4$ ohm. The total current would then be $\frac{1.7}{.4 + .006 + .035} = \frac{1.7}{.441} = 3.8$ amperes, which is still entirely inadequate. It would take ten of these cells in parallel before a current of sufficient strength could be obtained. Even so, a battery of these cells would be unsuited for the purpose, because cells of this class are unable to furnish a heavy current except for very short intervals, polarization taking place very rapidly, reducing the current-strength.

If we select some cells with a higher E. M. F. and lower resistance, such as bichromate cells or cells with very low internal resistance as, for instance, the Edison-Lalande cell, better results will be obtained. Selecting two cells of the latter class with an E. M. F. of .7 and an internal resistance of .03 ohm, we would, by arranging them in series, receive a current of $C = \frac{2 \times .7}{2 \times .03 + .006 + .035} = \frac{1.4}{.101} = 13.8$ amperes. This is, also, entirely insufficient, but we notice at once the advantage over the other two cells in series. To obtain something like 20 amperes from this class of cells, four are required, arranged two in series and two in parallel.

When the minimum internal resistance is desired, we have to resort to the storage-battery, where the resistance may be about .005 ohm and where the discharge, theoretically, may be at the rate of $\frac{2.0}{.005} = 400$ amperes. This high rate of discharge is, of course, not permissible, because it would ruin the plates: but even so, the possible rate of discharge is so high that an ordinary voltaic battery cannot compete with it.

The method pursued above for ascertaining the current-strength is to use formula (a), Art. **128**, *Direct Currents.* This is usually sufficient, but those who wish to go a little further may use formulas (d) and (e), Art. **135**, and formula (g), Art. **136**.

CURRENT-SUPPLY FOR THE CAUTERY

18. The Bichromate Cell.—Regarding the most convenient method for supplying the current to the cautery, it is needless to say that the ordinary lighting circuit takes first place, next to this comes the accumulator, and last the primary cells. Among the latter, the *bichromate cell*, Art. **35**, *Direct Currents*, has occupied a prominent place, because it has a high E. M. F., a comparatively low resistance, and is able to deliver a heavy current for some time without polarization. There are many forms in the market, mostly consisting of a combination of a number of single elements. Fig. 2 shows a

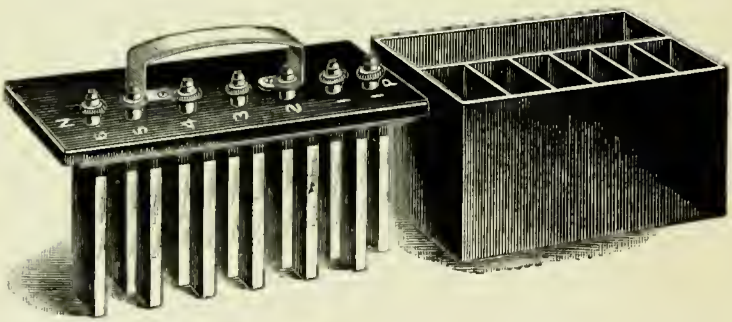

FIG. 2

form provided with a tight cover, which allows the liquid to splash about inside without spilling. In a bichromate cell the zinc should always be removed when not in use, in order to prevent local action. This is here accomplished by raising the cover and turning it around so as to place the plates in the empty side of the case. The other half is divided into cell-compartments, each containing an electrolyte. Fig. 3 shows another form where the electrolyte is kept in a bottle when not in use. Numerous other forms are produced, so as to make the

cells more portable. These cells all need a certain amount of care, if they are to be relied on when wanted. If not systematically inspected, they are liable to fail when any heavy service is required of them.

In Arts. **92** and **94**, *Direct Currents*, are given some particulars relating to the care of these cells. It should here be added that in a bichromate cell there is no liberation of gas and, therefore, no motion takes place in the electrolyte whereby the exhausted parts of the solution may be made to move away and make room for the fresh parts. The strengthening of the old solution goes on mostly by means of diffusion, unless the plates are lifted at intervals so as to set the liquid in motion. It is therefore of importance to have the electrolyte in a concentrated form, and this cannot be done with bichromate of potassium, even if dissolved in hot water. But, if bichromate of sodium is used in its place, it can not alone be dissolved in cold water, but almost in any quantity. A battery will then need less frequent renewals of the electrolyte, and will be able to furnish a heavier current for a longer time without being subject to a decrease by the diminished action of the electrolyte. Carhart recommends the following solution: Dissolve 7 ounces of sodium bichromate in 1 quart of water, and to this should be added 5 fluid ounces of strong sulfuric acid. The solution is ready for use as soon as it cools. When the battery begins

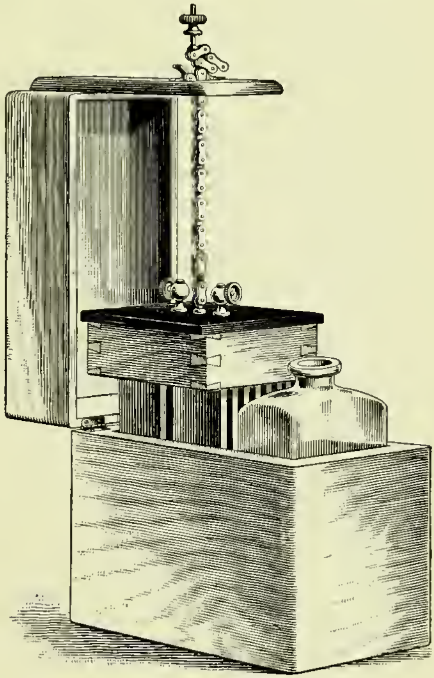

FIG. 3

to show signs of exhaustion, add from 1 to 1.5 ounces of acid per quart of fluid.

When it is intended to use a bichromate battery for cautery work, it is advisable not to have the zincs in contact with the electrolyte longer than is absolutely necessary, and after use the zincs should be washed out in water. If the cautery current has been one of great strength and taxed the battery to its limit, it is better to throw the liquid away, unless it still has sufficient strength to run the battery for other purposes where a current of small strength is required.

19. The Edison-Lalande Cell.—When a battery is desired for office-work alone and not for transportation, then the *Edison-Lalande* battery is very serviceable. It will keep in working order for a long time without any attention, except an occasional examination every 2 or 3 months to ascertain the height of the liquid, as the latter will evaporate even when covered with oil. The type "W" cell has a resistance of about .02 ohm, and one cell can, for a short time, deliver a current of 33 amperes, if necessary; but usually they are put up in combinations of three cells, when they can also be used continuously for motors and similar work, and are able to supply a current of over 20 amperes. The lack of success that some operators have had with these cells is mainly caused by not following the rules given by the manufacturers. Another cell, based on the principles of the Edison-Lalande cell, is the *Gordon* cell. It is somewhat different in construction, but otherwise there is little difference between them.

20. Dry Cells.—Some *dry cells*, such as the "New Standard," "Hydra" battery, and others, have also been used for cautery work and to a great extent for lamps. They require no attention and are very suitable for transportation. Their resistance is not as low as that of the fluid cells and they cannot be renewed, but many operators prefer these disadvantages to those of having to keep the cells in working order and to handle acids, etc.

21. Care of Cells.—Regarding the care of cells, then, the essentials have already been given in Art. **92**, *Direct Currents.*

It may be added that sometimes a battery, which otherwise seems to be in perfect order, fails to give the usual current-strength. In this case the fault may lie with one single cell, which either has a wasted zinc or some loose contact. It is well, then, to give each separate cell a close examination and, preferably, to test them by means of a voltmeter.

22. Storage-Battery.—Whenever a storage-cell can be conveniently charged it is preferable to a primary cell, provided it is in frequent use. If this is not the case, then it is better to have one of the primary batteries mentioned, because a storage-battery, if not submitted to a certain amount of work, will deteriorate in a short time. The price paid for it had then better be devoted to a primary battery. Complete information about the storage-battery has already been given in Art. **57**, *Direct Currents.*

The main point about a storage-battery is the rate of its discharge, taking care that it does not go beyond that indicated by the manufacturer. If so, buckling and sulfating are liable to occur, and it will never be able to run at its full capacity again. The charging of the battery should also be at the stated rate. As a transportable battery, it has great advantages by being able to deliver a heavy current without too much bulk. If regularly used, then a systematic charging process should be gone through with at regular intervals, so that the battery is always charged and ready for service. If the lighting circuit is not available, a primary battery must be resorted to, and then every available moment should be used for charging purposes. Otherwise a very large primary battery is required in order to finish the charging process within a reasonable time. When ordering a storage-battery, the purpose for which it is to be used should be stated, and also the means for charging it. The manner in which a primary battery is used for charging accumulators is fully described in *The Physics of Roentgen Rays.*

If the 110-volt incandescent-light circuit is utilized for charging purposes, then the arrangement shown in Fig. 4 may be made. The current comes in through the conductor *a* from the main circuit and passes through a number of incandescent

lamps, depending on the desired current-strength. In this instance ten lamps of 16 candlepower are installed, each permitting $\frac{1}{2}$ ampere to pass, therefore a total of 5 amperes. From here the current passes through a fuse and switch to the adapter, ammeter A, and accumulators. In parallel with the battery is inserted the voltmeter V, enabling the operator to ascertain the progressive state of the charging at the same time as the

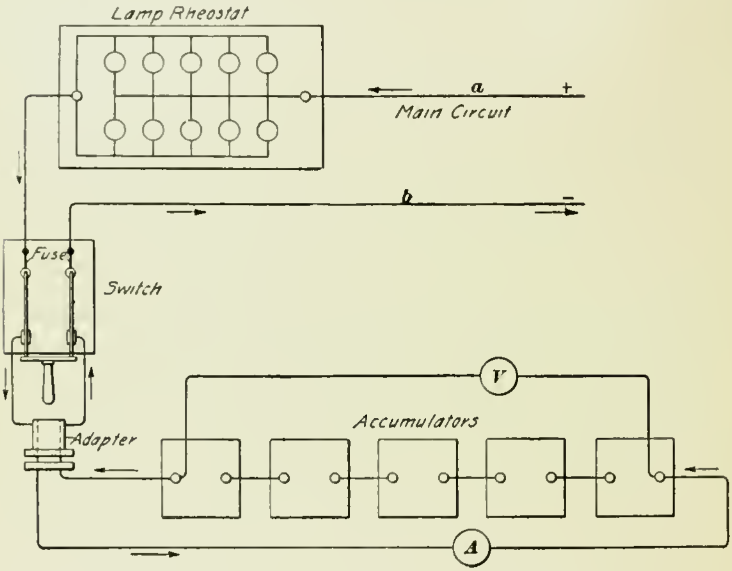

Fig. 4

ammeter A indicates the rate at which it takes place. From the battery the current returns again through the adapter, switch, fuse, and main conductor b.

When a primary battery is used for charging it is important to have a rheostat in the circuit whereby resistance may be thrown out of the circuit when the charging progresses. This is to counteract the counter E. M. F. of the accumulator, which constantly increases while the charging is going on, tending to decrease the current-strength. The latter should be kept as nearly constant as possible. If too great, gassing and buckling may be caused. The method for calculating the time of charging

the storage-battery has been given in Art. **30**, *The Physics of Roentgen Rays.*

23. Lighting Circuit.—The minimum of attention is required on the part of the operator when the incandescent-lighting circuit is utilized. All that is required under this arrangement is simply to close a switch and the current is flowing. Ordinarily there are two kinds of currents available, the *direct* and the *alternating.* The most universally useful of the two is the direct current, because the alternating cannot be used in cataphoresis, electrolytic, and galvanic treatments. For cautery and lamps it is immaterial which current is used.

It would seem natural to suppose that a 110-volt lighting current could be used directly for cautery purposes, and that by inserting a resistance-coil or a number of incandescent lamps of suitable resistance in parallel, any current-strength could be obtained. But this method has certain drawbacks that make it objectionable. A cautery has a very low resistance, and, to send a current of the required strength through it, demands a comparatively low pressure. For instance, let the united resistance of the cautery and conductors be .1 ohm; then, with a pressure of 110 volts the amperage would be $C = \frac{E}{R} = \frac{110}{.1} =$ 1,100 amperes. As the required amperage rarely goes beyond 25, and usually is much below this, it is clear that a large resistance must be inserted in the circuit to bring the pressure within reasonable limits.

Suppose that we desire a current of 5 amperes for a cautery of .035 ohm's resistance. It is then necessary to insert a resistance in the circuit, in series with the cautery, sufficiently large to make the joint resistance of the cautery and conductors equal to 22 ohms, as found by Ohm's law, viz.: $R = \frac{E}{C} = \frac{110}{5} = 22.$ Let the united resistance of the cautery and the conductors be .1 ohm, then the resistance of the rheostat would be $22 - .1 =$ 21.9 ohms. The reduction of pressure that takes place in this resistance is $E = C \times R = 5 \times 21.9 = 109.5$ volts, and the number of watts lost is $W = E \times C = 109.5 \times 5 = 547.5$ watts, a

useless waste amounting to 99.4 per cent. of the total 550 watts at disposal. It is therefore necessary to find other means whereby the available pressure may be reduced to one suitable for the operation of the cautery. This is done by transforming a current with a relatively high voltage to one with a lower voltage, but with an increased amperage. If the current is *alternating*, this can be done by means of a transformer in the manner described in Arts. **58** to **62**, *Essential Apparatus*. Various designs of these transformers are in the market, some more efficient than others. That one shown in Fig. 5 is not of a very high efficiency and requires a heavy primary current to produce an E. M. F. high enough for sending a heavy current

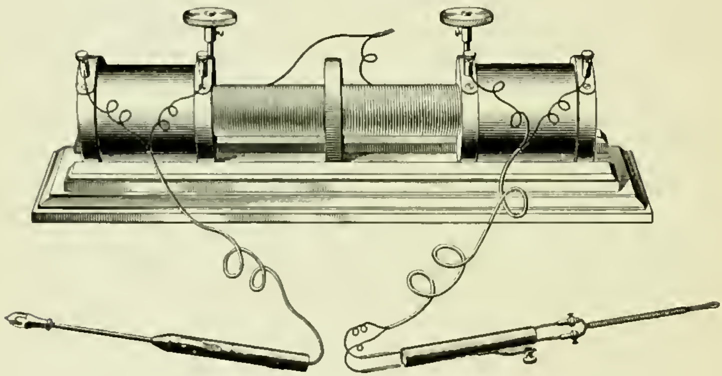

FIG. 5

through the movable secondary coils, one of which is used for the cautery and the other for light. This is because the lines of magnetic force have to complete their outside paths for a long distance through air, making the magnetic circuit one of high resistance, and therefore requiring a correspondingly heavier current to produce the same results as an apparatus in which the lines of force may travel almost entirely through iron. A transformer of the latter class is shown in Fig. 6. Here the primary and secondary coils are entirely enclosed in laminated iron. The strength of the cautery current is regulated by means of the hand-wheel on top that moves a small lever from one button to another. Each button means an addition of one-half

volt, the maximum current having a voltage of 6 volts. The transformer can be attached to any ordinary lamp-socket of a 55- or 110-volt circuit, the three binding-posts to the left being

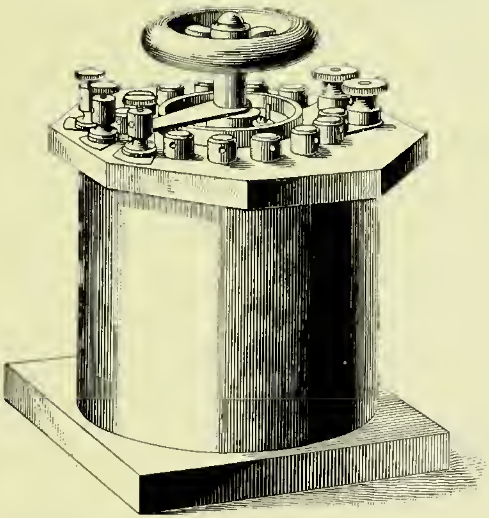

FIG. 6

for that purpose. On the right are binding-posts for the cautery connections.

When the *direct* current has to be transformed, the procedure is not quite so simple, because a motor-generator, or rotary-converter, is required in addition to the transformer. A motor-generator consists, in reality, of an electric motor that is operated by a direct current. On the motor shaft is also a supplementary armature that revolves in the magnetic field of the motor and has an alternating E. M. F. produced in it, suitable for the operation of the transformer shown in Fig. 6. In Fig. 7 is a diagram showing the connections of the motor-generator with the lighting circuit, transformer, and cautery. *A* is the current-tap, inserted in any lamp-socket, from which the conductors *a*, *a* transmit a 110-volt current to the motor brushes of the motor-generator *B*, setting its armature in rotation. An alternating current of 70 volts is then taken from the collector-rings on the left side of *B* and sent through the conductors *b*, *b* to the

transformer C, where it is changed into a 6-volt alternating current, with a corresponding increase in amperage. This current is now led through the conductors c, c to the cautery D.

When buying apparatus of this class it is always advisable to specify the voltage of the circuit from which it is intended to

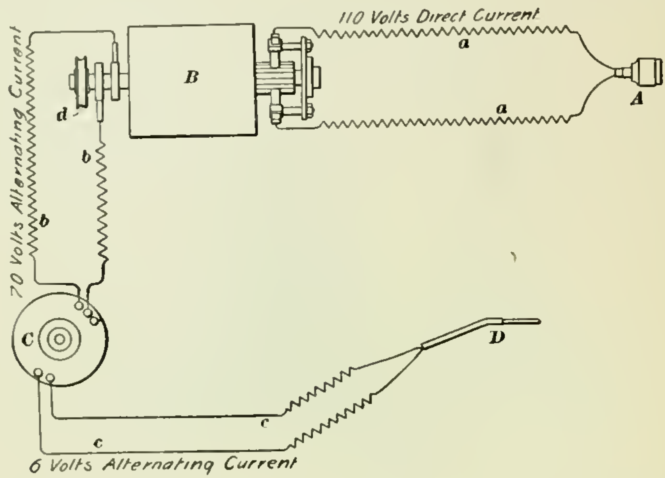

FIG. 7

derive the operating current. The construction of the apparatus varies with the variation in voltage. The motor can also be used for any other purpose where driving power is required, such as static machines, centrifuges, etc.

CAUTERIES

24. In Art. **16** was explained the theory of the cautery, and it remains here to treat of its practical construction and of the variations in form that the various purposes for which it is used demand of it. Platinum is the metal that is almost exclusively used for cauteries, though at times thin steel and iron wires have been utilized for the same purpose. Platinum has the advantage over other metals that it is of a high specific resistance and low specific heat, and of a high fusing temperature, therefore not easily melted when exposed to a high temperature.

25. Construction of the Cautery.—The resistance of a cautery seldom exceeds .1 ohm, while the volts vary between 2 and 6 and the amperes between 1 and 50. A broad knife may take as much as 25 to 30 amperes at a pressure of 1 volt. If the cautery is a long, thin wire, considerable more E. M. F. may be needed, but the total energy transformed into heat may be small, because the resistance is higher.

Some cauteries are made rather heavy; this should be avoided, as thereby the resistance is lowered, and, consequently, a heavier current is needed to reach the same temperature. There is then more danger of the rest of the circuit also getting heated, resulting in an increase of resistance and waste of power. The copper conductors to which the platinum loop is attached should be of ample size and well insulated. The difference in pressure between these two copper wires is not great, but it is, nevertheless, important that no current passes from one to the other before it flows through the platinum loop. Therefore, the insulation should be good and should be of such material that it can be readily sterilized. Usually silk and asbestos are used for this purpose, being covered with varnish to make it waterproof. It is needless to say that absolute cleanliness should be the rule, so as to prevent organic matter from being lodged between the conductors.

26. Resistance of the Cautery Circuit.—In Art. 16 attention was called to the importance of having the whole cautery circuit, external to the cautery itself, of a minimum resistance. This emphasizes the importance of having all the joints and connections perfect, electrically considered. Metallic oxids are poor conductors, and, if found on any of the electrodes and joints, must at once be removed. For instance, the ends of the cautery that are inserted in the handle should always be examined, and, if oxidized, should be rubbed off with some fine emery-paper; likewise, the ends of the conducting-cords that are inserted in the other end of the handle. The connection between the several elements of the battery should also be frequently inspected, as corrosion is, in particular, liable to occur in the presence of acids.

It has already been remarked in Art. 15 that the cautery, after coming in contact with moist tissue, is considerably cooled. As a consequence, some allowance should be made so that the

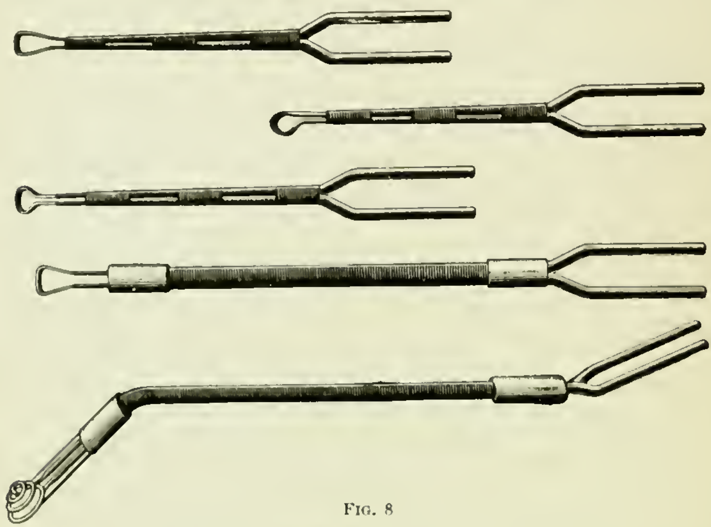

FIG. 8

cautery may receive a somewhat heavier current when in active operation than that which seems sufficient to make it glow while surrounded by air.

27. Variety of Cauteries.—Fig. 8 shows a few forms of cauteries most in use. Where a larger incandescent surface is required, a loop or spiral of platinum, supported in grooves on a porcelain mount, is made as shown in Fig. 9, the porcelain being heated to redness with the platinum.

FIG. 9

28. Cautery Handle.—Fig. 10 shows the cautery handle into which any of the cauteries may be inserted and, likewise, part of the conducting-cords by which the current is sent from the transformer to the cautery.

The aim should be to have the cautery handle light and well balanced, otherwise the delicacy of the operations, for which the cauteries, as a rule, are used, are interfered with.

The metal handle should be well insulated from the end sockets into which the conductors and cautery are inserted.

Some handles are provided with an interrupter for starting and stopping the current through the cautery. This has some objections, mainly this, that the hand of the operator has to perform an additional motion, which of necessity must interfere with the stability of the cautery. A better method would be to use a foot-switch or to have an assistant do the starting or stopping of the current.

29. Cautery Snare.—For the removal of a greater quantity of tissue the electrocautery snare is used. The ordinary handle, as shown in Fig. 10, may also be used for operating this snare,

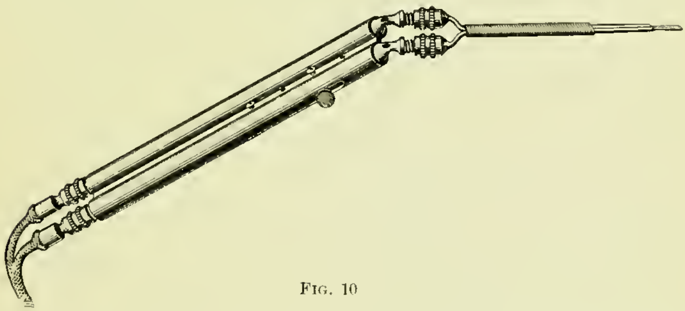

Fig. 10

and is then provided with a little wheel by means of which the platinum snare may be drawn up. This arrangement does not seem to be very satisfactory, as it is difficult to produce an even pull and to prevent a certain jerkiness. In many operations where the cautery snare is used, it is required to submit the latter to a constant pull, and, in some cases, of considerable strength. The handle, Fig. 11, is constructed with the aim of fulfilling these requirements. Here the fingers are inserted in the three rings, and by bending the fingers towards the thumb, the snare is drawn in with an even motion and with a speed that can be easily regulated. When using the snare it should be remembered that, while it is being drawn into the handle, its resistance is constantly decreasing. The resistance of the circuit should, therefore, be correspondingly increased, otherwise there is danger of the platinum wire being overheated and

melted. The snare handle here illustrated has a resistance that is automatically increased while the snare is being shortened.

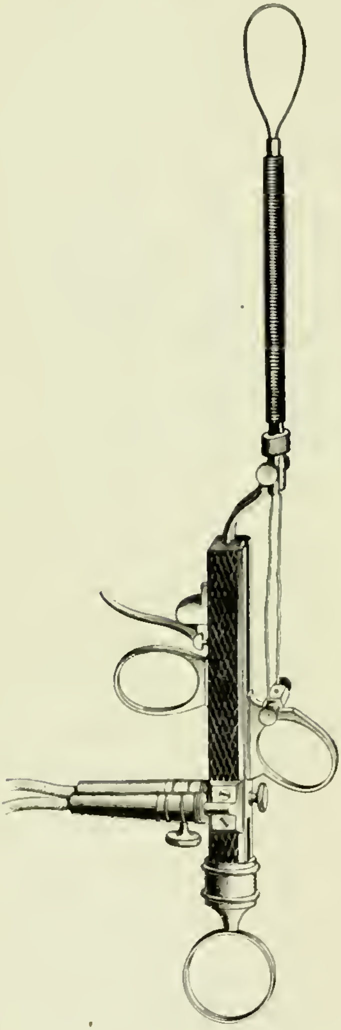

Fig. 11

Fig. 12

30. Bottini's Incisor.—A special form of cautery is *Bottini's* incisor, Fig. 12, used for incision of the prostrate

gland. The female shaft *F* contains the cautery knife *P*, which may be moved in or out by turning the wheel *H*. To keep the shaft cool while the cautery is heated, a stream of cool water is circulated through the handle *G* and shaft *F* by letting the water pass in through the pipe *K* and out through the pipe *K'* *C* is a plug that, inserted in a sleeve, connects it with the copper conductors. The advantage of the cautery is perhaps here shown at its best. While the shaft is being inserted the blade *P* is entirely covered and the whole is cold. The current is sent through the cautery after the desired position has been found and the operation performed in about a minute, after which the cautery is again sheathed, the current cut off, and the whole withdrawn in a cool condition.

ELECTRIC LIGHTING

INCANDESCENT LAMPS

31. The Filament.—The active part of an incandescent lamp is a thin filament of carbon mounted on platinum wires that are sealed in the neck of an evacuated glass globe. The thickness of the filament determines the resistance of the lamp and, thus, the voltage necessary to send a current of a given strength through it. In some small lamps a platinum wire is used in place of the carbon filament. More care is then required in using the lamps, as a current of too great intensity is liable to fuse the platinum.

32. Unit Candlepower.—The light that an incandescent lamp emits is measured in candlepowers, some lamps having as little as $\frac{1}{2}$ candlepower and others as much as 1,000. The standard candlepower is the light produced by a candle burning 2 grains of spermaceti wax per minute.

33. Variation in Candlepower.—The lamps ordinarily used for offices and operating-rooms are 16 candlepower, which is abbreviated to 16 c. p. The number of candlepowers that a lamp is able to give out depends on the amount

of electric power that the lamp transforms into light and heat. We have already seen that electric power is measured in watts, and the number of watts that a lamp utilizes is found by multiplying together the pressure and strength of the current through the same.

For instance, the resistance of a lamp may be 220 ohms and the voltage 110. The current-strength is then $C = \frac{E}{R} = \frac{110}{220} = .5$ ampere. The product of voltage and amperage is $110 \times .5 = 55$ watts. The number of watts required to produce 1 candlepower varies between 3 and 4.5; small lamps used for diagnostic purposes may require as much as 8 watts per candlepower. Counting, in this instance, 4 watts per candlepower, we find the candlepower of this lamp to be $\frac{55}{4} = 13.75$. This is when the lamp is new, but its candlepower is not constant. A gradual decrease of the latter goes on, caused partly by the disintegration of the carbon filament, whereby its diameter is reduced and its resistance correspondingly increased, and partly, also, by the deposition of the removed carbon particles on the inside of the lamp-globe. The latter is thereby made more or less opaque and the efficiency of the lamp reduced.

The lamps used for diagnostic purposes vary in illuminative power from 1 to 16 candlepower. The pressure required for their operation is usually between 4 and 110 volts. It is clear that the same candlepower may be produced by lamps of varying voltage and amperage as long as the watts consumed are the same. For instance, a lamp of 10 volts and .75 ampere would, theoretically, have the same candlepower as one with 6.5 volts and 1.25 amperes. In both cases the number of watts utilized is 7.5, but in general it is found that lamps using more than .9 ampere are more efficient than those requiring a smaller current-strength.

The table on the following page shows, approximately, the variations in voltage and amperage for the same candlepower.

34. Selection of Lamps.—When procuring ordinary diagnostic lamps, considerations should be had of the available

voltage and a lamp selected that is most suitable for it. To be on the safe side it is well, for small lamps, to count about 8 watts per candlepower. The following example will show how such calculations are to be carried out. To find the total number of watts required for a lamp of a given candlepower, multiply the candlepower of the lamp by the number of watts

TABLE III

1	c. p.	from	3 volts and	.8 ampere to	8	volts and	.3	ampere
2.5	c. p.	from	5 volts and	1.4 amperes to	25	volts and	.45	ampere
5	c. p.	from	5 volts and	3.0 amperes to	65	volts and	.35	ampere
8	c. p.	from	10 volts and	2.8 amperes to	120	volts and	.3	ampere
16	c. p.	from	15 volts and	3.7 amperes to	160	volts and	.4	ampere
25	c. p.	from	40 volts and	2.2 amperes to	120	volts and	.7	ampere
32	c. p.	from	50 volts and	2.3 amperes to	120	volts and	.9	ampere
50	c. p.	from	50 volts and	3.5 amperes to	120	volts and	1.4	amperes
100	c. p.	from	50 volts and	7.0 amperes to	120	volts and	2.9	amperes

per candlepower, or, total watts $W =$ total candlepower $\times$ watts per candlepower. For example, an 8-candlepower incandescent lamp requires 3.5 watts per candlepower; how many watts are needed for its operation? $W = 8 \times 3.5 = 28$ watts. A current of 10 volts is available; how many amperes will it require? According to Art. **20**, *Direct Currents*, $W = E \times C$, therefore, $C = \frac{W}{E} = \frac{28}{10} = 2.8$ amperes.

35. Selection of a Battery.—The same battery that will serve to operate a cautery will not, as a rule, be able to run an incandescent lamp unless the battery is rearranged to fill the new requirements. The reason for this is that in a cautery we have to do with a very low resistance, perhaps as small as .025 ohm, while in an incandescent lamp the resistance may be as high as 400 ohms, depending on the candlepower of the lamp and the pressure of the current. In the cautery it is a question of developing a maximum of heat, and in the incandescent lamp a minimum heat with a maximum of light.

As the lamp has a resistance so much higher than that of the cautery, it is necessary to have a battery with a high E. M. F.

and a relatively small current-strength. The resistance of the battery in this instance plays a more subordinate rôle, because the amperage is small, and, therefore, the product of current into resistance, that is, the loss of potential, cannot reach the height it would in a cautery circuit. It is thus seen, that while in a cautery-battery the aim is to produce a maximum current-strength by putting the cells in *parallel*, in an incandescent lamp-battery the aim is to produce a higher voltage by placing the cells in *series*. Whether either of these combinations alone is sufficient to produce the desired voltage or amperage will depend to a great extent on the E. M. F. and the resistance of the individual cells, and on the current-strength demanded either by the cautery or the lamp.

Suppose, for instance, that an incandescent lamp with a resistance of 4.8 ohms requires a current of 1.25 amperes to bring it to proper incandescence. A battery of six Edison-Lalande cells, used for the cautery, is at hand, and it is desirable to ascertain if these are able to run the lamp. The E. M. F. of each cell is .7 volt and internal resistance .03 ohm. Arranging the cells in series we find the current-strength, according to formula (*b*), Art. 128, *Direct Currents*, to be

$$C = \frac{s\,e}{s\,r + R} = \frac{6 \times .7}{6 \times .03 + 4.8} = \frac{4.2}{4.98} = .84 \text{ ampere.}$$

The result shows that this number of cells is entirely inadequate for lighting this particular lamp. This does not mean that a greater number of cells may not do so, or that another lamp requiring less pressure may not be run successfully.

On taking six bichromate cells, each of 1.9 volts E. M. F. and .5 ohm's resistance, we find, on arranging them in series, that they will give a current of $C = \dfrac{6 \times 1.9}{6 \times .5 + 4.8} = 1.46$ amperes, a current of sufficient strength to light the lamp and to allow the insertion of a resistance for regulation.

The number of watts utilized in a lamp may, of course, be varied, either by increasing the E. M. F. or the amperage of the current, or by decreasing the resistance of the circuit, the latter method being accomplished by the use of a rheostat. It should be remembered, however, that increasing the candlepower beyond

that at which a lamp is rated is very injurious and results in a quick deterioration of the same.

36. Using the Lighting Current.—The other means used for operating the diagnostic lamp are the same as those used for the cautery, with the modifications in E. M. F. and current-strength, which have already been mentioned. The transformer shown in Fig. 5 is made both for light and cautery, the coil on the left giving the current for the light and on the right for the cautery. In other cases the current is received directly from the lighting circuit, but may then have to be reduced to the required voltage by means of a rheostat, which is not a very economical method. Rotary transformers may also be used for this purpose, from which a current is received with the correct voltage. When the commercial current cannot be obtained, recourse must be had to a battery, either made up of voltaic cells or storage-cells. Voltaic cells in the form of dry cells have also been used successfully.

37. Portable Battery.—When using voltaic cells for office-work, the gravity, bichromate, and Edison-Lalande cells are all serviceable. For portable purposes the dry cells are the most desirable. The formulas given for combining cells for cautery purposes are also used when calculations have to be made to ascertain the best combination for operating a given lamp. As a lamp of, say, 8 candlepower is made for a voltage varying between 10 and 120 volts, it is well to procure a lamp of a voltage that will be run by a battery of minimum weight, when intended to be portable. If, for instance, the voltage is too high, then a large number of cells are required, which, in case of a storage-battery, would be inconvenient. It would here be better to have the voltage as low as possible in order to require a minimum number of cells. For portable purposes the dry cells are to be preferred. They are not quite as economical as the ordinary cells, but they are very clean, require no attention, and do not deteriorate when not in use. They may be bought in quantities ready for replacing worn-out cells. This matter of deterioration is quite an item with storage-batteries,

and unless they are used very frequently they are rather expensive and troublesome to maintain in good working order.

38. **Head-Light.**—For diagnostic purposes the lamp is required to light only a limited area, and for this reason it is possible to concentrate the illumination in one direction. Consequently, the illuminative power of the lamp for a given area may be increased fourfold to fivefold, depending on the area and the means used for concentration. It is also of additional advantage to have the operator's eyes shielded from the lamp, in order to study the illuminated parts to the best advantage.

FIG. 13

Such an instrument is shown in Fig. 13, where the lamp with its reflector and condenser is fastened by means of a belt. The operator is then allowed the use of both hands and can also change the direction of the light to suit the requirements. When it is impossible in this manner to throw the light on the parts desired, as, for instance, in throat and nasal examinations, a hand-lamp may be used, as shown in Fig. 14.

39. Cystoscope.—When it is desirable to illuminate cavities and observe the surrounding walls, such as the stomach or bladder, it is necessary to send the light reflected from these

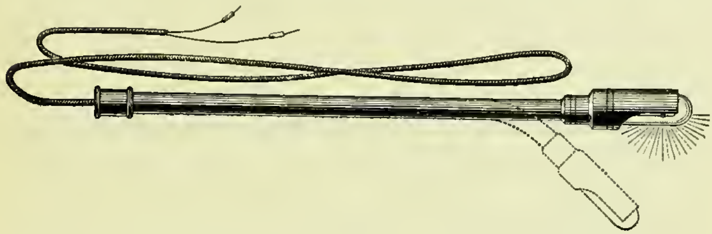

Fig. 14

walls through a long tube and to enlarge the image thus found by means of suitable lenses. This is done by means of the cystoscope illustrated in Fig. 15. *A* is the lamp situated at the extreme end of the tube *T*. *B* is a prism that receives the image and refracts it through the tube in a longitudinal direction and through a lense placed at *G*, where it is magnified. As the lamp generates some heat, several designs have water

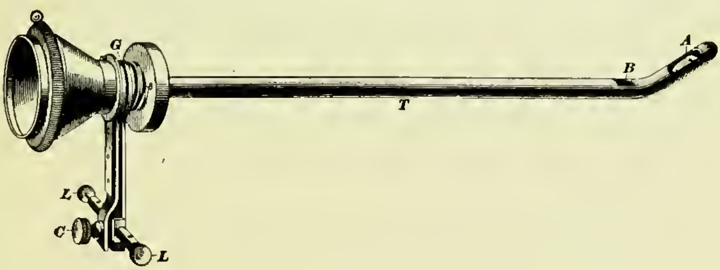

Fig. 15

circulating through the tube for the purpose of cooling it. The filaments in these small lamps are quite delicate and they should be handled with care to avoid permanent injury.

40. Urethroscope.—Fig. 16 illustrates an improved form of urethroscope in which the lamp is held more securely than in most other forms, and where there is less danger of getting the application entangled with the lamp. The main tube is marked *a* and is provided with an opening at its extremity through which the obdurator *b* projects. The latter is grooved

on its under side so as to allow space for the lamp. The tube, obdurator, and lamp are all introduced simultaneously into the urethra, as shown in Fig. 16 (a). The handle h is provided with studs f, to which are attached the conducting-cords from the battery. On the front and rear of the handle are push-

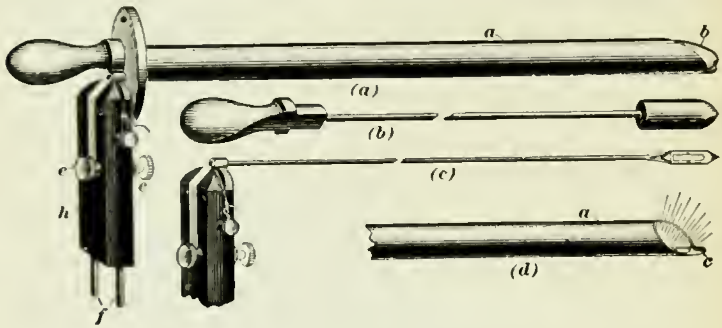

FIG. 16

buttons e for starting and stopping the current. Fig. 16 (b), (c), (d) shows the obdurator, the lamp with its carrier, and the tube a without the obdurator. By reason of the position of the lamp there is more direct illumination of the urethra, and the degree of heat imparted to the urethra by the lamp is reduced to a minimum.

Electricity in Diseases of the Eye, Ear, Nose, and Throat

Electricity in Diseases of the Eye, Ear, Nose, and Throat

INTRODUCTION

1. If the century just passed has signalized no great discovery or achievement beyond the recognition of the principles of electricity and their development, that era might justly be written down the "golden age." The quantity of research stimulated by the labors of Volta and Galvani has been enormous and the results have surpassed the highest expectations of man.

It is a strange truth that genius is the product of a fostering parent—time. At certain periods there are born a troop of masters who rule the intellectual world for a lifetime and then pass beyond, leaving for their underlings a lapse to be utilized in the learning and appreciation of their works.

At the close of the 18th and beginning of the 19th century there were Humboldt, Davy, Ampere, and Faraday, scientists and philosophers; Goethe, Coleridge, and Byron illumined the literary sphere; Bach, Beethoven, and Mozart filled the earth with purest melody. These men were but few of that great academy of poets, philosophers, and scientists. We are watching now the first gray streaks of the dawn of a new cycle. It is not beyond the bounds of prediction to say that we shall soon listen to the teachings of new masters and catch the flash of jewels, brighter and more luminous than the old, in the crowns of genius. The age is ripe for a new array of giants. There is needed a skilful hand to collect the good and useful and throw out what is indifferent; a master mind to classify and arrange our varied stores of knowledge. Our vast library needs to be recatalogued.

2. In the new order of things there should be some impetus which shall lead us to a fair and comprehensive study of facts; which shall help us to a fair and impartial judgment. We are prone, it is feared, to condemn and lay aside the things which we little understand. The common fate of every prophesy is ridicule and unbelief, simply from the fact that what is told is beyond our ken or without our understanding. Those of us who have four decades only to our credit may remember with what reserve were accepted those valuable instruments of utility—the telephone and the electric light. Many a man of business refused to avail himself of the advantages a telephone affords until he saw his more progressive competitor surpass him in the footings of his day-book. The electric light was regarded as an illumination too bright for normal eyes. Many a farmer was prone to swing the cradle and bind his grain by hand long after he might have profited by the use of the self-binder.

In education, as well, the truth applies. Have we not heard of the instructor who awakens to find himself deprived of his charge because he was not abreast of more progressive methods? The practice of law has undergone radical changes in late years, so that there now exists the specialist in copyright law, in banking law, in the law as it relates to patent rights, and in many particular divisions of the whole. The man of today who would follow the old teachers and aim to be a general practitioner will find the rocks of adversity ahead.

3. In no profession or walk in life, perhaps, is the necessity for broad-minded consideration and liberal study so imperative as that of the practice of medicine. The physician has moral responsibilities greater than his coworkers in other lines. He deals with the principles of life itself where others traffic in its products.

The specialist is the logical outcome of study and environment. He is trained by the demands of his practice. It is but natural that the individual who has particular advantages for the observation and study of one thing, be that what it may, should know more about it than he who merely reads or casually takes notice. It is not our intention to plead for specialism, but it *is*

our wish to plead for a broader and more generous recognition of the truths that specialists have demonstrated. Let us at least give trial before we condemn, before we accept. The celebrated reply of John Hunter to his student, who said he *thought*, was "Do not think, work!" The French philosophers confronted Franklin with the question whether the fish, thrown into the bucket of water, would add to the water's weight. "Let us try the experiment," said the philosopher.

4. Electricity in therapeutics is a scientific entity and its application an art. If one were to build a bridge or construct a locomotive, he must follow the exact principles of engineering and mechanics. If a surveyor would lay out a road, his plans must be mathematically correct or his grade will be faulty. So, too, in electrotherapeutics, the operator must work according to fixed and well-established laws, and his instruments and appliances must be constructed after most precise plans.

For many years the very word electricity was synonymous with mysticism; this was no doubt due to the fact that the rudiments of the science were known to charlatans and made use of by them in a way to startle and beguile the people. When Franklin drew lightning from the clouds and thereby revolutionized the theories of his day, the mass of people associated electricity with tempests and the supernatural. But though these factors have caused damage to a measure, they have stimulated research as well. Many of the foremost of our scientists have devoted their intellectual wealth to the study of the science with the result of firmly establishing it as an exact science, and our best workers in medicine, many of them, have taught us the definite and invariable principles of the art.

With these principles before us we have all the materials for the experiment. Why do we not try it? The reason is partly to be found in the shortcomings of our medical schools as regards instruction in electrophysics. This portion of the curriculum is neglected sadly. Some of our leading colleges offer courses in electrotherapeutics and electrophysics, but many students are deprived of these advantages. The practitioner, if he be a busy one, must acquire this learning as best he may, or not at all.

To the students and practitioners who have taken the lessons in electrophysics preparatory to instruction in electrotherapeutics, let us say that these lessons are of inestimable value, partly because they embrace all that is essential for a working knowledge, and partly because the unnecessary elements, which would tend to confuse, have been eliminated.

5. The specialist in medicine, in whatsoever field he may be working, cannot afford to ignore the value of electricity as one of his therapeutic resources. There are certain ends it will bring about and certain results it will offer that no other agent can vouchsafe. It will by no means accomplish everything, even though the principles be correctly applied, and it certainly will yield nothing if they be wrongly or carelessly put to use.

For many years electricity has been used in the treatment of some of the diseases of the eye, ear, nose, and throat. Much has been written upon the subject by workers in every country, and hundreds of cases have been reported showing the beneficial effects of various currents properly applied. In spite of all that has been done and written, we search the modern textbooks well nigh in vain for enlightenment on the subject. Some authors barely mention electrical treatment, while others frankly state that they have had no personal experience with its application Whether these conditions arise from a lack of appreciation, from an aversion, or from a lack of study, it is hard to say. Be this as it may, the fact remains that the student derives little benefit from the usual sources, and must needs seek his knowledge elsewhere.

Many of the affections of the eye and upper respiratory passages are amenable to treatment by the various forms of electricity, and in some conditions electrical treatment is the rational procedure par excellence, and will accomplish what nothing else will. With these ideas well in mind we shall turn our attention to the consideration of the application of electricity in diseases of the eye, ear, nose, and throat. We shall make use of galvanism, or direct currents, faradization, or induced currents, electric light, the electrocautery, magnetism, electrolysis, cataphoresis, and Roentgen, rays.

The principles of these forms of electric energy are now well understood by the student, and it remains to demonstrate their appropriate selection and application.

Before beginning a consideration of the various diseases and their treatment, we shall devote some time to the various instruments and appliances necessary and useful to the work.

ESSENTIAL APPARATUS

6. Source of Current.—The current requisite for all practical applications of galvanism, faradization, and electrolysis may be obtained in a variety of ways. In cities where

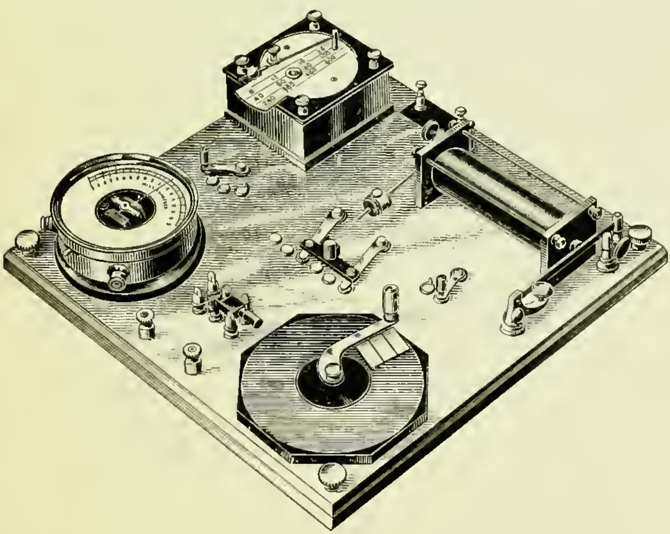

FIG. 1

Table-Plate

the ordinary 55- or 110-volt constant current for incandescent lighting is available, this will be found very serviceable and convenient. The currents of high voltage in street-car and arc-lighting circuits are dangerous, and should not be used. Some lighting companies will furnish *power*, as it is called, which is generally a constant current of 100 volts or over. If

the practitioner is unable to obtain either of these sources of energy, he has still several resources. A battery of cells may be used. These cells may be of any desired pattern, but the ordinary "sal-ammoniac" cells will be found as satisfactory as any. These should be mounted upon shelves in a convenient place in the physician's office, or arranged in a cupboard or beneath a table. This battery should contain from thirty to fifty cells connected *in series*. The terminal wires should be connected to binding-posts so situated as to be within easy reach of

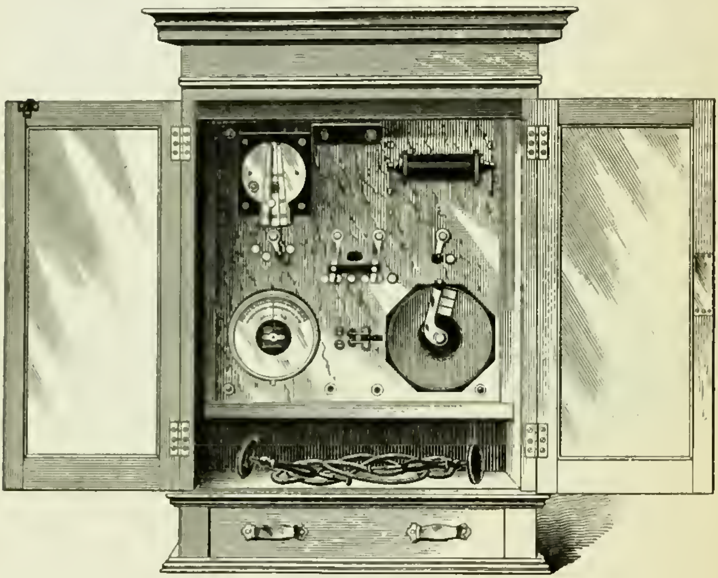

FIG. 2
Wall Cabinet

the operator's hand. The terminals may be connected to the proper posts on a table-plate, Fig. 1. Where a wall cabinet, Fig. 2, can be afforded, in the lower shelves of which the jars are stored, the arrangement will prove very compact and convenient. The fluid batteries occasion some annoyance at times on account of leakage and corrosion, particularly in the cells of the bichromate type. Some operators have discarded them entirely because of the care they require. The general

objections to fluid batteries may be met by substituting *dry cells*, of which there are several patterns. The silver-chlorid cells are much used. They are portable and, with ordinary handling, unbreakable.

7. Control of Electric Current.—We have thus far considered the sources of the current only. How shall it be controlled and measured to suit the individual cases? Let us suppose we are using the current from the incandescent-light

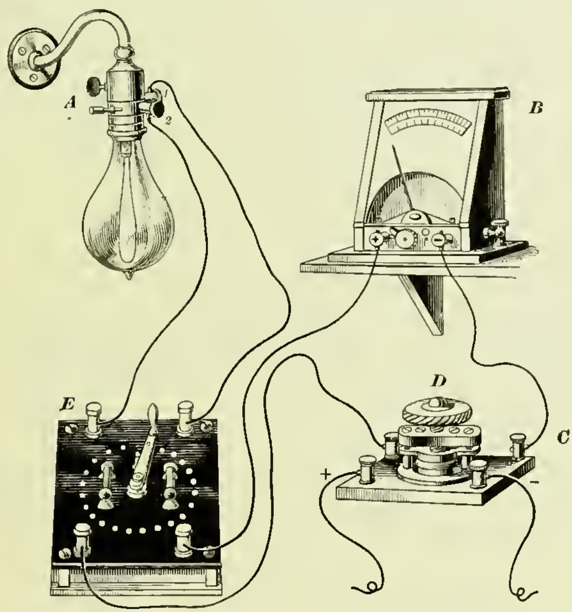

FIG. 3

Scheme for Utilizing the Current of an Incandescent-Light Circuit

circuit, the voltage of which is 110. Fig. 3 illustrates a scheme of adaptation. *A* is a current-adapter, which is inserted into the ordinary light-socket and brings a lamp into series, thus limiting the current to about $\frac{1}{2}$ ampere. *1* and *2* are binding-posts from which wires pass to posts in *E*, which is an instrument known as a *selector*. By this contrivance any voltage from 1 to 110 may be obtained. In the circuit passing from *E* to

the patient are two appliances, *B*, a milliamperemeter, or milliammeter, which bears a direct reading or absolute scale, and indicates the exact amount of current passing, and *C*, a current-controller, or rheostat of carbon. By turning the thumbscrew *D*, the finest gradations of current may be made, even to fractions of a milliampere. Any arrangement of the apparatus will suffice so long as a rheostat and a milliammeter are always in the circuit. Interrupters, pole-changers, and induction-coils may be placed in circuit as needed. Many of the table-plates

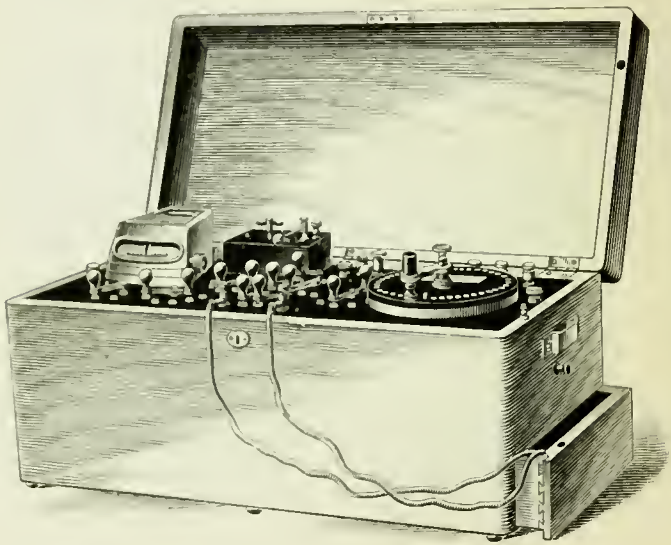

FIG. 4

A Convenient Form of Dry-Cell Battery

and wall cabinets contain all these accessories. A most convenient variety of dry-cell battery for general work is shown in Fig. 4 (see Art. 50, *Direct Currents*), wherein all essentials are arranged in a compact space. A very desirable rheostat (see Art. 25, *Essential Apparatus*) is shown in Fig. 5. This instrument furnishes the scale of resistances in ohms on its face. It may be used either with the galvanic current or the induction-coil. Fig. 6 shows another form of rheostat. Liquid rheostats

are shown in Figs. 23 and 24, *Essential Apparatus.* Fig. 7 illustrates a convenient milliammeter (see Art. **11**, *Essential Apparatus*). It must not be supposed, however, that costly

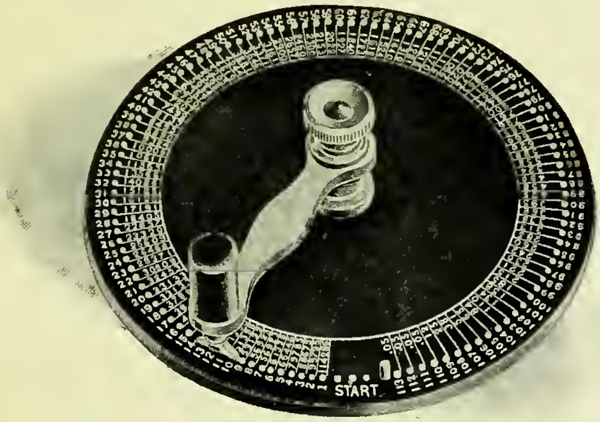

Fig. 5

A Direct-Reading Rheostat

apparatus and appliances are necessary for successful work to be done. An ingenious workman may arrange at very

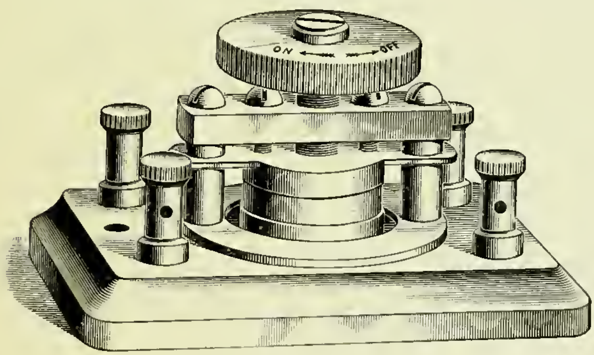

Fig. 6

Another Type of Rheostat

trifling expense an apparatus suitable for office-work. For instance, a battery may be made of cells made from ordinary tin cans, iron filings, a few porous cups, and carbon points.

Such a cell is shown in Fig. 8. A home-made rheostat consists of a **U**-shaped tube of glass and a wire plunger and spring, as shown in Fig. 9. We have used such apparatus and found it very serviceable.

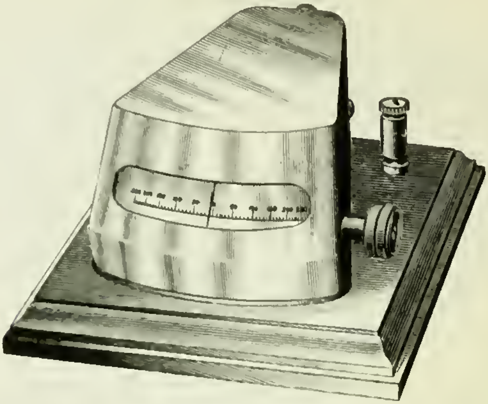

Fig. 7
A Convenient Milliammeter

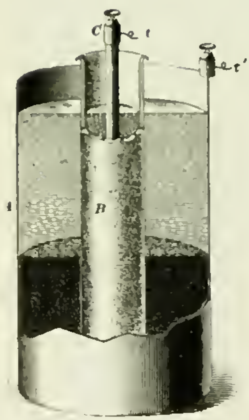

Fig. 8
A Cheap, Home-Made Battery

8. Electric Needles, Handles, Etc.—In the selection of electrolytic needles, handles, and electrodes, the physician should avail himself of the best only. Needles should be of gold, platinum, or, preferably, iridoplatinum. Such needles do not corrode or oxidize. They may be insulated according to the use for which they are intended. The selection of various styles of handles and electrodes is a matter of preference with the physician. The cords, connections, and binding-posts should be of the best quality (see Fig. 10). Test them thoroughly before using. Many of the electrodes designed for special use will be described as occasion arises for their use. Where simple galvanism is to be administered the electrode may often

consist of a piece of clean copper wire or a probe, wrapped with absorbent cotton that has been moistened with a salt-solution consisting of 1 dram of common salt to 1 pint of distilled water. Cataphoresis requires special electrodes made of different materials, such as pure copper or zinc. These will be spoken of later.

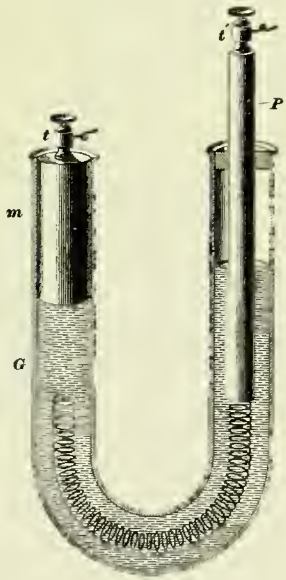

FIG. 9
An Easily Constructed Rheostat

9. Incandescent Current. When the incandescent current is available, such an apparatus as shown in Fig. 11 will be found most convenient and reliable for office-practice. *A* is a motor-generator, of which there are many patterns. Fig. 12 shows another design. These are useful for operating drills, saws, etc. It generates an alternating current. *B* is a double induction-coil wound for a light at one end and for a cautery at the other. These coils have rack-and-pinion adjustment. With the use of such an instrument, which serves as a transformer, the necessity of a rheostat is obviated. *C* is a foot-plate, permitting the operator to make and break connections at will without the aid of an assistant.

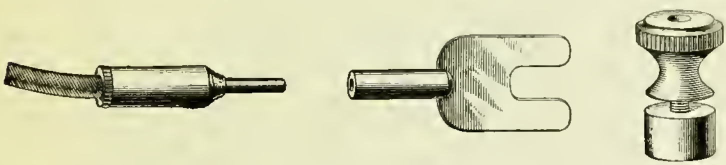

FIG. 10
Herdmans' Post and Connections

10. Storage-Battery.—The storage-battery, Fig. 13, may be used, always with a rheostat in circuit, and is of considerable advantage because it is portable. The requirements for

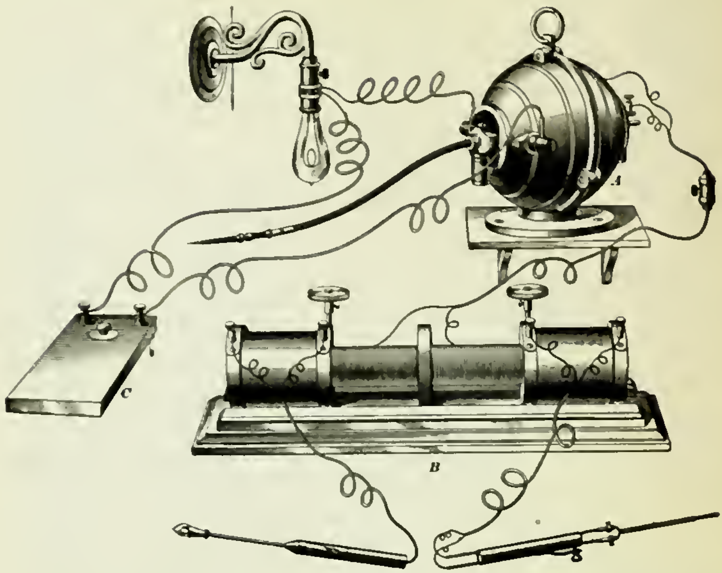

Fig. 11

Illustrating the Adaptation of the Incandescent Circuit for Heating Diagnostic Lamps and Cauteries

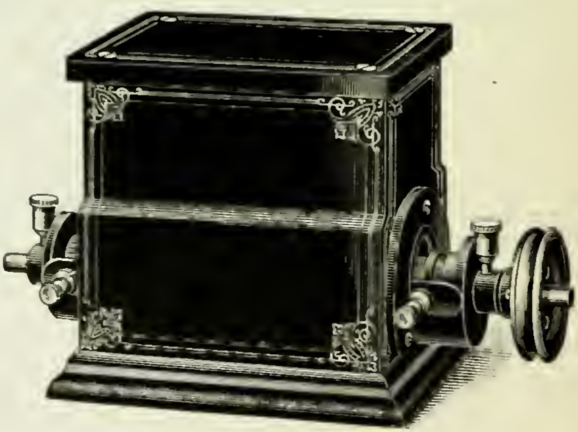

Fig. 12

A Type of Motor-Generator

heating a cautery, it should be borne in mind, are altogether different from those for electrolytic or galvanic applications. Electrolysis requires the E. M. F. of many cells or a high voltage to overcome high resistances in the tissues. The same is necessary to heat an incandescent light of 16 candlepower. But to heat a cautery the E. M. F. of two cells is sufficient, provided these cells are of large size. Practitioners who utilize batteries may bring about this requisite by connecting the cells in multiple-arc or *parallel*. This does not increase the E. M. F., but decreases the

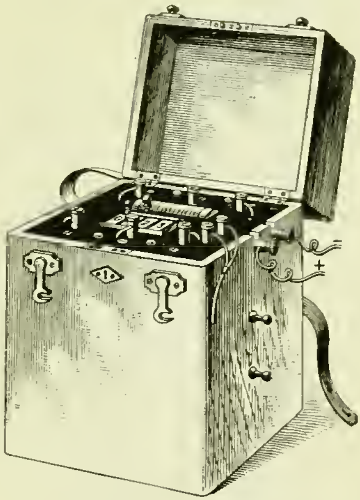

Fig. 13
Storage-Battery

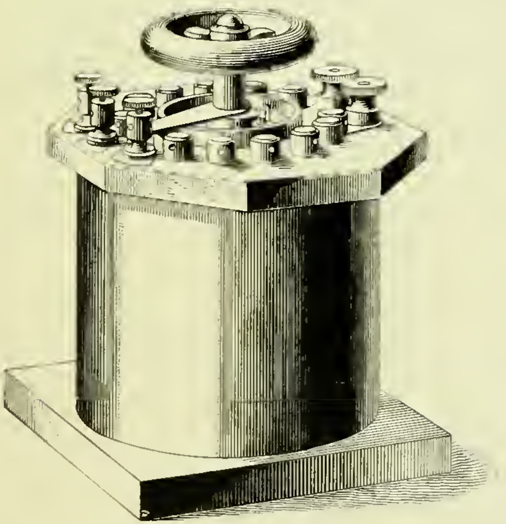

Fig. 14
Transformer

internal resistance. The current from cells in parallel or from the 110-volt circuit will fuse a cautery-knife at once. Some physicians use large bichromate batteries for cautery-work.

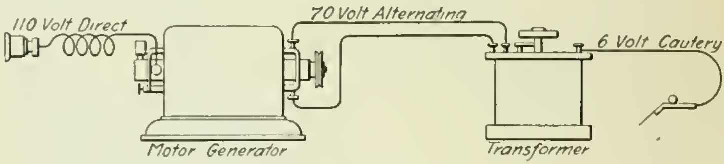

FIG. 15

Showing the Principle on Which Generators and Transformers Operate

They are to be used only where other means are lacking. Accumulators require to be charged frequently from a source giving a constant current of not too high voltage, the E. M. F. of which is greater than that of the accumulator itself. Fig. 14 shows a transformer of good pattern. The principle on which motor-generators and transformers operate is illustrated in Fig. 15.

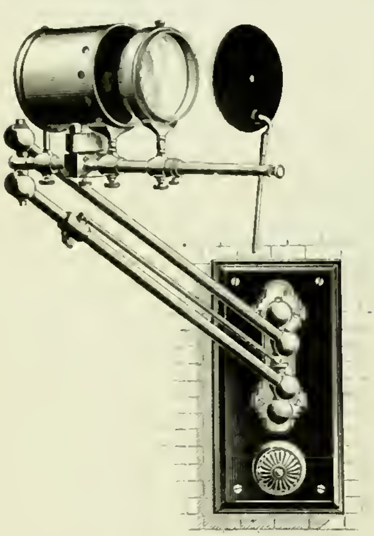

FIG. 16

Illuminator

11. Illumination. For purposes of examination and treatment, the physician is guided in the selection of his artificial light largely by individual preference and taste. The old Argand burner is still largely used. Many use incandescent lamps of 16 to 32 candlepower. Suitably mounted, these are ordinarily adapted for the specialist's use. Fig. 16 shows a good arrangement. We have found the ordinary acetylene bicycle lamp very serviceable. It yields

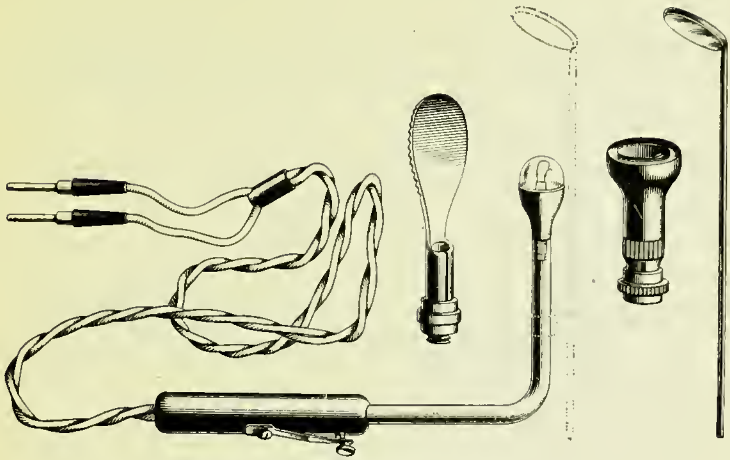

Fig. 17

Pharyngeal Electrodiagnostic Lamp

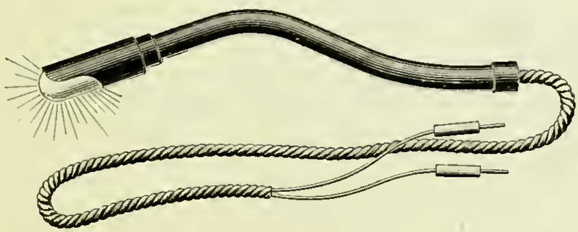

Fig. 18

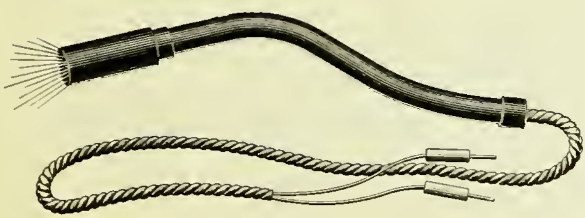

Fig. 19

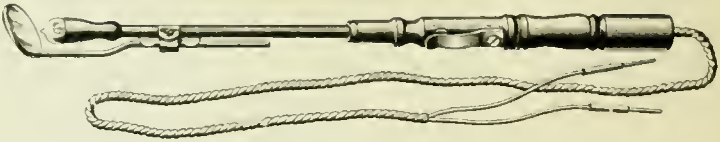

Fig. 20
Nasopharyngeal Lamps

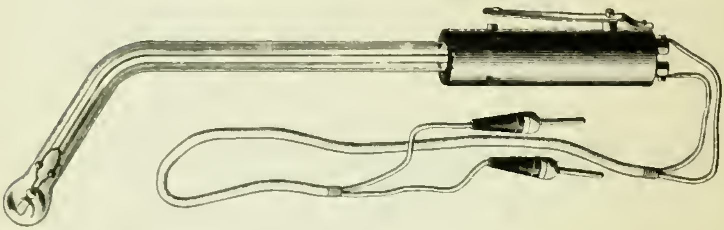

Fig. 21
Laryngeal Illuminator

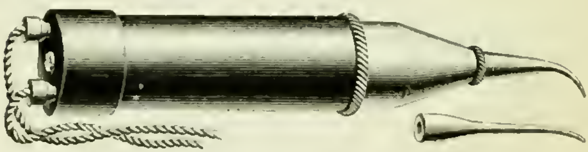

Fig. 22
Single-Cell Electromagnet

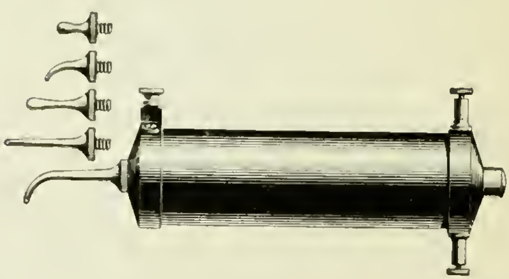

Fig. 23
Hirschberg's Magnet

a steady, strong, white light. The slight odor and trifling annoyance of recharging the lamp are its only faults. Figs. 17 to 21 show some of the electrodiagnostic lamps for use about the nose, throat, and larynx.

12. Electromagnets.—In the removal of metallic foreign bodies from the eye the electromagnet will be of service. A magnet of small size that can be operated by one cell is shown in Fig. 22. It is useful only in removing small particles of metal lying loose in the conjunctival sac. A portable, yet quite strong, magnet is that shown in Fig. 23. It has several adjustable tips to meet different emergencies. Haab's magnet, shown in Fig. 24, is the most powerful electromagnet of all. It is intended for the removal of particles of iron or steel embedded in the tissues of the eye and for the most part inaccessible. Further mention of these magnets will be made later.

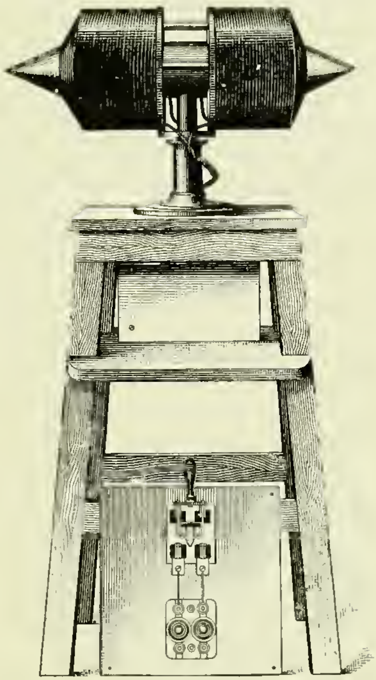

FIG. 24
Haab's Magnet

13. Apparatus for the Generation of X-, or Roentgen, Rays.—For a description of the various sources of the cathode rays the student is referred to *The Physics of Roentgen Rays*. The larger modification of the Ruhmkorff coil and the improved modern static machine are the sources most frequently and advantageously employed.

DISEASES OF THE EYE

14. In the treatment of the various affections of the eye and contiguous parts, it must be borne in mind that a rational system of therapeutics is based on a correct understanding of pathology. Some conditions may be due to remote and constitutional disturbance rather than to causes purely local. In every case, therefore, the practitioner will aim to remove or ameliorate the primary factor in the disease, whether that be local or general, and will use every agent consistent with the teachings of experience, both to bring this about and to restore the parts to their normal condition. The applications of electricity frequently need to be supplemented with further local treatment, or electricity may simply serve as an adjuvant to some other plan of procedure.

DISEASES OF THE LIDS

TRICHIASIS AND DISTICHIASIS

15. Trichiasis and **distichiasis** may arise from a variety of causes, the principal one of which appears to be a proliferation about the epithelial structures of the hair-follicles. A constant hyperemia or inflammatory condition of mild degree about the margins of the lids may bring this about. The cilia frequently take an erratic direction and grow inwardly upon the eyeball, causing, by the irritation they produce, considerable pain and spasm of the lids. So great may the irritation become that it will lead to ulceration and opacities of the cornea. A similar condition is frequently seen in entropion.

16. Treatment.—The treatment consists in removing the surplus and erratic hairs. Ordinary epilation will not suffice, since it does not prevent a return of the trouble. Electrolysis offers the best results in all cases where the cilia are not too thickly grouped or too abundant. Following the proper application of this method the hairs do not return.

17. Place in circuit a rheostat and a milliammeter, and so govern the current that the needle of the meter stands at zero. Attach to the cathode, or negative terminal wire, a fine steel, or best, an iridoplatinum needle, inserted into a needle-holder of convenient type (see Fig. 25). To the anode, or positive pole, or terminal, attach an electrode well wrapped with absorbent cotton, which is to be moistened with salt-solution.

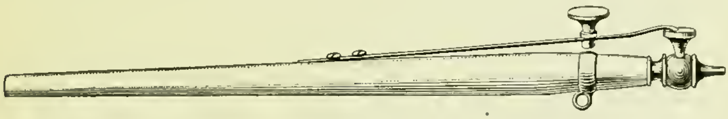

Fig. 25
Needle-Holder

Should there be any doubt as to which pole is the cathode and which the anode, place both terminals in a dish of water. Hydrogen bubbles will collect at the cathode if the current is operating. Place the patient in a good light before you, adjust the anode either to the patient's hand or apply it to the neck or cheek. The electrode shown in Fig. 26 may be applied to the malar prominence, and will be found serviceable in other applications of electricity about the eye. With the eyelid slightly everted and steadied by the hand of an assistant, grasp the hair to be removed with cilia-forceps and pass the needle alongside the hair at its base, into the follicle, and beyond. The circuit should now be closed and the rheostat operated, so as to allow a gradual increase of current from 0 to 4 milliamperes. In from 10 to 50 seconds the tissues about the point of entrance of the needle will begin to look white, and tiny bubbles of gas appear. Slight traction on the hair will remove it. Withdraw the needle. The electrolytic action of the current has caused a slough about the site of the follicle and destroyed it.

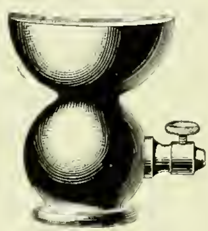

Fig. 26
Electrode

18. The operation, though not severe, causes some pain. From three to ten hairs may be removed at a sitting, according

to the fortitude of the patient. There is usually profuse lacrimation and slight hyperemia may result for a few hours. Sittings may be held as often as every other day. It is advisable to allow an interval of 24 hours or more to elapse between these applications, in order to permit all irritation to subside. In cases where the cilia are in such abundance as to make their removal by electrolysis impracticable, some one of the methods of excision or transplantation will be found more serviceable. It must not be forgotten that the cicatrix resulting from multiple applications of the electrolytic needle within a small space is by no means slight.

HERPES ZOSTER

19. Nature.—**Herpes zoster**, which is a painful and sometimes dangerous affection, is due to derangement of some of the branches of the supraorbital or infraorbital division of the fifth nerve. The disease is self-limited and seldom calls for active therapeutic measures, save when the herpetic vesicles appear on the cornea, in which case ulcers and opacities are the rule. The condition is ushered in by slight, if any, constitutional disturbance, but the pain is burning and intense. After a few days, pain diminishes and the vesicles appear either in a discrete or confluent form—usually the former.

20. Treatment.—The treatment consists in soothing applications, the hypodermic use of morphin when necessary, and close attention to complications if they arise. The application of a constant electric current to the diseased parts and to the closed lids, of intensity just sufficient to cause a feeling of warmth, will be found serviceable in mitigating the pain and lessening the severity of the attack. Either pole may be made the active one, and it is well to change the polarity frequently during the sitting.

RODENT ULCER

21. Nature.—This variety of epithelioma is usually a companion of advanced years, and runs a characteristically slow but certain course. In its early stages, when it appears as a small shallow ulcer covered with a scab, situated usually at the

inner canthus of the eye, it is particularly suited for electrical treatment. In some cases electrolysis accomplishes a speedy cure without the necessity for more vigorous intervention. It must be understood that the treatment, of whatever character it may consist, must be directed well beyond the diseased focus into healthy tissues in order to destroy the morbid process and prevent a recurrence.

22. Treatment.—The ordinary method of treatment consists in the thorough removal of all diseased tissue with the knife and the application of the thermocautery or some chemical caustic to the base. The application of saturated solutions of chlorate of potash to the parts, together with the administration of the drug in full doses, has met with some success. Electrolysis should always be tried in cases where the ulcer is accessible, small in size, and in its earlier stages. The mode of application is as follows: Select a new, sharp needle of iridoplatinum and attach it to a holder carrying the anode terminal wire. The cathode, or indifferent pole, is to be attached to a convenient electrode, which may be applied to the patient's cheek. Introduce the needle into the *healthy tissues* beneath the base of the ulcer at one margin parallel to the plane of its surface. With the milliammeter at zero, gradually increase the current until 5 to 8 milliamperes is passing, and maintain this intensity for 2 or 3 minutes. The current should now be shut off and the needle withdrawn and introduced at a point nearer the center of the margin of the ulcer. In this manner the entire base of the ulcer and the healthy tissues beyond are subjected to electrolytic action. The anode causes a coagulation of the tissues and the blood-vessels supplying the part. A necrosis of the peripheral tissues occurs and the slough separates, leaving healthy granulation tissue, which soon cicatrizes. Should the operator experience any difficulty in withdrawing the needle after passing the current, he may overcome it by simply reversing the polarity for an instant. It is never wise to tear the needle rudely from the tissues. This treatment may be given in one sitting or in divided sittings. In the former case it is well to anesthetize the patient.

23. Another means of applying electrolysis is what is termed the *bipolar method*, in distinction to that just outlined, which is sometimes spoken of as the *unipolar*, or *monopolar*, *method*. In the bipolar method we make use of an electrode specially devised (see Fig. 27). The needle-holder is so arranged as to bring the anode and cathode into close proximity without actual contact. Many operators claim better results by the use of the bipolar method. The results are

FIG. 27
Needle-Carrier for Bipolar Electrolysis

the same in either case. The needles are introduced in the manner described above and the application of the current is the same. The parts should be protected after the operation and kept thoroughly aseptic. Should recurrence take place more radical operative steps will be necessary and should not be deferred.

TUMORS OF THE LIDS

24. Chalazion.—These little cysts vary in size considerably and seldom give the patient much annoyance unless they become large enough to interfere with the functions of the lid or open spontaneously into the conjunctival sac. More than one may be present at a time. It is impossible to cause these tumors to disappear by any means other than operative.

25. Treatment.—Incision into the cyst through the conjunctiva and thorough curettage of its walls is the ordinary method of dealing with the condition. Electrolysis is very serviceable and should be afforded a trial before the more extensive plan outlined above is attempted. An iridoplatinum needle is made the cathode and introduced into the tumor on its conjunctival surface. It may be introduced on the exterior, in which case the needle should be insultated to the point where it touches the skin, so as to avoid possible sloughing. The

indifferent electrode may be applied to the brow or the neck. A current of 2 milliamperes should be passed through the tissues for a period of 2 or 3 minutes. The séance may be repeated in 24 hours. One or two applications will suffice for cysts of ordinary size.

26. In cases where the lids are greatly thickened from an old chalazion or from a series of sties, the application of the constant current may be useful. Grasp the tissues of the lid by a specially devised electrode or by an ordinary pair of tissue-forceps, which is made the cathode terminal. The anode may be placed at any site. A gentle current of from 1 to 2 milliamperes is to be applied at regular intervals for 4 or 5 minutes at each sitting. The tough and brawny condition frequently clears up materially after a few applications.

27. Cancer, Sarcoma, and Fibroma.—These tumors of malignant and non-malignant type need no special or detailed description. The pure fibromata are the only growths which are not malignant in character and which may permit of delay in removal. All malignant tumors should be attacked early and radically. It is to be recalled that these disseminate rapidly through the lymphatics and blood-vessels.

28. Bipolar electrolysis applied thoroughly to the bases of the tumors in this situation offers a certain means of removal. It will accomplish nothing beyond the original focus and will not prevent the growth of metastases which have already occurred. The method of application consists in passing the needle into the bases of the tumors well beneath the diseased tissue and administering a current of from 1 to 10 milliamperes for 2 to 5 minutes, according to the conditions present. It is essential to electrolyze the tissues around and beyond the entire base of the disease. If, for any reason, it is considered necessary to use a higher amperage, an anesthetic will have to be used.

29. Vascular Nævi.—These disfiguring blemishes of the eyelids offer the most favorable field for electrolytic work about

the eye. The treatment is the same as in nævi elsewhere about the face or body. Some operators prefer to use the cathode, others the anode, as the active pole. Certain it is that in nævi of a telangiectatic type the anode is always to be preferred. The sittings may be held as often as every other day. The current should vary between 1 and 2 milliamperes, and the length of its application 1 or 2 minutes. Always attack the nævus at its periphery except where the wart is very small. The needles should be of iridoplatinum or platinum.

LUPUS

30. Electrolysis may be employed in the treatment of the stubborn condition known as **lupus**. Good results are frequently brought about. The more brilliant results attained by the use of Finsen phototherapy should encourage operators to avail themselves of the method where possible.

FIBRILLARY TWITCHING OF LIDS

31. This rather annoying condition may be benefited by the stabile or labile application of a gentle constant current. Moistened electrodes are used. The anode is to be placed on the closed lids or gently rubbed over them, or the moistened fingers of the operator may be made the anode, and the lid gently stroked.

ENTROPION AND ECTROPION

32. The pathology of these affections is so well understood that there will be no necessity to dwell thereon. In general, there are but two forms common to each, the cicatricial and the muscular. We shall deal with the former alone. The cicatrix may be so extensive as to involve the tarsus, a point which should be borne in mind. The complications and sequelæ attendant upon entropion are largely those following distichiasis, and the operations mentioned under that head are applicable to mild cases. Unless a great number of hairs impinge on the cornea their removal by electrolysis will be of great benefit and relief to the patient.

33. Treatment.—For the various operations employed in the relief of these conditions, the student is referred to text-books on the eye. Electrolysis has met with slight favor. In entropion of a mild nature due to contracture, which does not involve the tarsus, we may make use of the electrolytic needle to considerable advantage. The principle is based on the sloughing action of the cathode and is used to break up the bands of scar-tissue in the eyelid. A steel or platinum needle slightly curved and mounted in a holder is made the cathode and is passed into the eyelid in the following manner: Introduce the needle at a point near the outer canthus of the eye about $\frac{1}{4}$ inch from the margin of the lid; carry it beneath the skin along the palpebral border to near the inner canthus, taking care to avoid the hair-follicles. The indifferent electrode is applied to the temple or cheek. A current of 5 milliamperes is passed for 5 minutes. It will be found on withdrawing the needle that the lid tends to assume more nearly its normal position, owing to the solution of the constricting bands. If one sitting is insufficient, a second may be held, passing the needle this time still farther back from the palpebral border. Unfortunately, the results of this operation are not always permanent.

34. The electrocautery may be used effectively in the treatment of both entropion and ectropion. Its application is based on a rational hypothesis, and consists in creating scar-tissue in the lid on the surface opposite to the direction of distortion, which, by its contraction, tends to restore the normal position of the structures. The method of application is as follows: Select a cautery-tip with a narrow, but not sharp, platinum blade and fit it to a convenient handle (see Figs. 28 and 29). By means of a transformer or rheostat so control

FIG. 28

Cautery-Tip and Handle

FIG. 29

Cautery-Tip and Handle Bearing Make-and-Break Key

the current as to bring the cautery-tip to a white heat. The patient should be anesthetized. If the lid is in a condition of entropion, steady it by means of Knapp's clamp and incise through the skin along the margin from the external canthus to the punctum lacrimal well down to the tarsal cartilage. The incision should avoid injuring the hair-follicles. The operation in ectropion is similar with the exception that the affected lid is everted and the incision carried along its conjunctival surface. A second incision parallel to the first and farther from the palpebral border may be required (see Fig. 30). The after-treatment requires cooling compresses and bandages to the eye. Ectropion and entropion due to atony and atrophy of individual fibers of the orbicularis palpebrarum may be benefited by faradization of the atrophied bundles with fine electrodes. Patiently continued for a long period this treatment will restore the position of the lid.

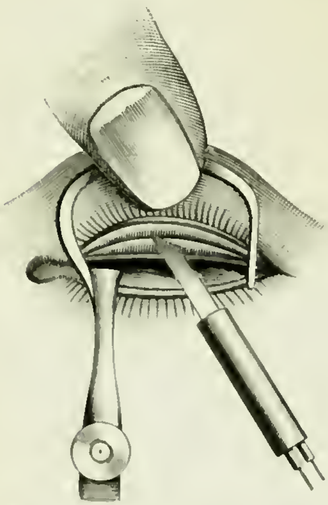

FIG. 30

The Electrocautery Incision in Entropion

DISEASES OF THE LACRIMAL APPARATUS

STENOSIS OF THE LACRIMAL CANAL

35. In stenosis of the lacrimal canal the stricture may occur at any point along the passage, either at the punctum, in the canaliculus, or in the nasal duct. In the first-named position the condition generally arises from blepharitis, or conjunctivitis, in the second from an extension of inflammatory processes or the presence of a minute foreign body,

while a narrowing of the nasal canal depends as a rule on the presence of long-continued nasal catarrh. The symptom common to all derangements of the lacrimal passage is the leaky eye.

36. In electrolysis we possess the most valuable of all therapeutic agents in the treatment of this disorder. The results of its application show a greater number of cures and a lesser number of relapses than with other methods. The operator may avail himself of the ordinary Bowman probes or he may obtain a set of graduated platinum sounds. The latter are better for the purpose. These sounds should be insulated to various distances from the tip with shellac or other substance, so that when in position the punctum and conjunctiva will not be subjected to electrolysis. This precaution is important since occlusion of the punctum has followed its neglect. The probe is to be passed into the passage in the usual manner until the constriction is reached and the tip of the instrument has gone slightly beyond. To the probe is attached the cathode-terminal. The anode may consist of a piece of copper wire or an ordinary probe wrapped with moist, absorbent cotton. This indifferent electrode should be introduced into the nasal chamber of the same side. With the needle of the milliammeter at zero, gradually increase the current until 5 milliamperes are passing. Continue the strength of current at this point for a moment and then gradually diminish until no current is discernible. This operation should consume from 3 to 4 minutes. Generally a little white froth will collect about the punctum. The probe will be found to lie much more loosely in the canal and may be withdrawn without difficulty, whereas it was firmly grasped by the tissues at its introduction. Each day for a week following the operation the probe should be passed, to prevent a subsequent narrowing of the canal. If a probe of larger size can be accommodated, so much the better. At the end of a week the operation may be repeated with a larger probe. There is very little pain or discomfort to be felt during the treatment, and the relief to the patient is most gratifying.

DISEASES OF THE CONJUNCTIVA

TRACHOMA, OR GRANULAR OPHTHALMIA

37. There is little to be said in regard to the acute form of this disease, since electricity is seldom if ever used for its relief. Other therapeutic agents yield better results. With the chronic form of trachoma, however, we shall deal to some extent and endeavor to establish for it a method of treatment well-nigh infallible. The pathological condition that confronts us has a varied picture, depending somewhat on the stage of activity of the morbid process. The disease acquires its name from the presence on the conjunctiva of small grayish granules, which are confined to the fornix and palpebral layers. Histologically, these granules are made up of lymphoid and fibrous tissue, and they are formed in the stroma proper of the conjunctiva. They are nothing else than small, new growths, which have a tendency to grow together into islands and, by the contraction of their fibrous elements, to obliterate the mucous surface of the lid and render it one mass of scar-tissue. The subsequent contraction of this scar-tissue is a cause of entropion, the treatment of which we have previously considered. A condition called pannus, or a vascularization of the cornea, is a frequent complication of the affection. We shall refer to it again later. Corneal ulcers are occasionally complications at some stage of the disease.

38. Treatment.—The inevitable tendency toward the production of scar-tissue, which characterizes the granular ophthalmia, should sound a note of warning in regard to treatment. Any method that requires the use of scarification or the application of caustics, or escharotics, should be condemned for the simple reason that it will increase the cicatrization. The aim must be to destroy the individual granulations or the fused masses which they form without injury to the areas of conjunctiva around and between them. By this means alone will a satisfactory outcome be obtained. The treatment by expression is one ordinarily in use and is very serviceable. Knapp's

cylinder forceps are employed for the purpose. Electricity has been used in a variety of ways. One method consisted in applying cupric cathodal electrolysis to the everted lids. It was based on an incorrect understanding of the action of the current. Another plan was to employ cupric cataphoresis or anodal diffusion, while still another form of electric application consisted in cathodal electrolysis, with steel needles, of the furrows produced by preliminary scarification. All these therapeutic hints have been supplanted by the more rational plan of dealing with these granules as new growths and electrolyzing their bases. The anode is made the active pole and to it is attached a fine needle of iridoplatinum. The moistened cathode plate may be adjusted to the neck. With the lid well everted and held steady, the needle is passed beneath the base of one of the granular masses. A current of 1½ to 2 milliamperes should be allowed to pass for 1 or 2 minutes, or until a whitish, cheesy mass is seen to form about the point of entrance of the needle. The nutrient vessels are coagulated and the granule undergoes coagulation necrosis and is quickly absorbed. If the granule is of large size, the needle should be passed in several directions beneath its base. Eight or ten of these masses may be treated at a single sitting. The reaction is slight and transitory and the hyperemia resulting is beneficial rather than otherwise. It is needless to say that the field of operation should be thoroughly anesthetized with a 4-per-cent. solution of cocain. An interval of 2 or more days should interrupt the treatment. A 3-per-cent. infusion of jequirity has been found useful where there is but slight blennorrhea, and particularly where pannus is present. The inflammation resulting from its use will frequently subside, leaving a clear cornea, but, unfortunately, the granular condition is not always correspondingly benefited. Its use is not unattended with danger.

39. Pannus.—The electrocautery is serviceable as an adjuvant to the operation of peritomy for the relief of obstinate *pannus.* The incision is made through the vascularized tissue and conjunctiva in the usual manner around the cornea about ¼ inch from its outer margin. The incision severs all tissue

down to the sclera. With the blunt extremity or flat surface of a platinum cautery-tip at white heat the inner fringe and circle of vascularized tissue is singed down to the anterior elastic layer of the cornea. This procedure is more radical and meets with better results than dissecting up the tissues to the corneal

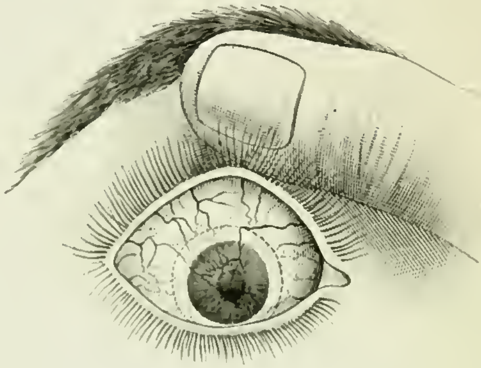

Fig. 31

Pannus, Showing Line of Proposed Cauterization

rim and there cutting them free (see Fig. 31). Cases have been reported where benefit was obtained by galvanization of the cervical sympathetic, the anode serving as the active pole.

PHLYCTENULAR CONJUNCTIVITIS

40. Where there is a solitary phlyctenula, puncture of the vesicle with a fine cautery-tip at a white heat will prove very satisfactory. The floor of the vesicle should receive a light touch of the heated cautery. A small bit of yellow oxid-of-mercury ointment, or still better, a bit of calomel powder, may be placed upon the eschar and ice applications employed. Phlyctenula of the cornea will receive attention later. The cautery is not available in cases where the phlyctenulæ are numerous or miliary in character. For the relief of pain, photophobia, and blepharospasm, in addition to the ordinary applications of cold and atropin, mild faradization is extremely

serviceable. Place an induction-coil in circuit and control the current so that only the slightest sensation is conveyed. Attach one electrode to a moistened sponge-plate and place it on the patient's neck at the back. The other electrode may be wrapped in moist cotton and laid gently upon the closed lids, or the special sponge-electrode, Fig. 32, may be used. The current may now be gradually increased to a point agreeable to the patient. The applications may be made a frequent intervals during the day, but should not continue longer than 5 minutes at a time.

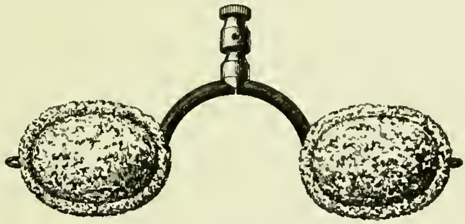

FIG. 32

Binocular Sponge-Electrode

PTERYGIUM

41. In the treatment of **pterygium,** electrolysis finds its proper sphere and bids fair to supplant entirely the ordinary operations of ligation and excision. A fine iridoplatinum needle is made the anode and is passed well into the neck of the growth, or at a point a trifle nearer the base, in a direction opposite or at a right angle to the direction of growth—crosswise. The cathode is applied to the back of the neck or upon the mastoid of the same side. A current of 1 to $1\frac{1}{2}$ milliamperes is allowed to pass for $\frac{1}{2}$ to 1 minute. The needle is to be withdrawn with great care, so as to avoid pulling or tearing the parts. Should the needle be firmly in the grasp of the tissues, reverse the polarity for an instant before attempting to withdraw it. Usually one sitting is sufficient. The eye should be thoroughly cocainized before all operations thereon. If we bear in mind the fact that in general the anode is the coagulating pole and the cathode the sloughing pole, we shall have little difficulty in effecting the desired electrolytic results. *Be certain of polarity always before applying galvanic currents.*

TUBERCULOSIS

42. The importance of an early diagnosis in **tuberculosis** cannot be too strongly urged. Essentially a chronic disease, the course may cover a period of several years before the eye becomes generally affected, but the danger lies not so much in the loss of the eye as in allowing a primary focus of tuberculosis to exist. General tuberculosis is a frequent sequel. The disease begins in the palpebral conjunctiva, generally in young individuals, as small grayish-yellow granulations that soon break down and form ulcers with clearly outlined margins and covered with reddish-gray granulation-tissue. The tissues of the lid become greatly swollen and the ulcerative process frequently extends to the lids themselves. Lupus reaches the conjunctiva by process of extension from the skin, and may be differentiated by the peculiarity of healing in one spot and progression in another, which is characteristic. The ulcers are a deeper red and bleed easily.

43. **Treatment.**—Either condition calls for prompt and thorough application of the electrocautery. With the eye thoroughly cocainized, bring the tip of the cautery to a white heat and sear each granulation and ulcer, taking pains to go deep enough into the tissues to destroy the morbid process entirely. Where possible, all diseased foci should be attended to at a single sitting, so as to avoid reinfection. Ordinary antiphlogistic measures should follow. Where the disease is so far advanced as to involve the iris or cornea, immediate enucleation of the eye offers the only recourse consistent with safety to the patient.

44. **Malignant tumors**, particularly in their earlier stages, call for prompt electrolytic treatment or removal with the knife followed by thorough applications of the electrocautery.

DISEASES OF THE CORNEA

45. Were we compelled to spend our days in habitations where the windows were of ground glass, we could the more easily appreciate the fate of the unfortunate individuals who have sustained corneal disease. Nearly all affections of the

window of the eye leave opacities of greater or less density and some lead to a more serious sequel—the complete loss of vision. It is readily understood, therefore, how important is a correct knowledge of the various morbid processes affecting the cornea and how untiring the specialist should be in the effort to combat the progress of disease and in the search for measures to alleviate the unfortunate sequelæ. We can afford to leave no therapeutic path unexplored. The opinion is ventured that the testimony of many persons who bear the *white eyes* will establish the fact that nothing was ever done for their trouble after the subsidence of the disease in its active stages. Many an opacity and stain have been removed, however, by the patient effort of a consistent worker who does not hesitate to employ remedies little known and to explore new regions in the effort to improve his resources.

KERATITIS

46. It will be unnecessary for us to review the pathology of the various forms of **keratitis.** The germ-theory of disease has thrown much new light on the subject, and demonstrated, in many cases, a system of treatment more rational than that in vogue a decade or two ago. An injury coupled with a microbic factor will lead to active inflammation. Suppuration is looked on as a complication rather than an essential to the healing of tissues.

Prominent symptoms in all forms of keratitis are *pain* and *blepharospasm.* In addition to the ordinary means for their relief the application of faradization will be found very useful. In fact, in all painful affections about the eyes, particularly of inflammatory character, the induced current should be given through the closed lids, using either sponge-electrodes or gently stroking the parts with the hand in circuit. The strength of current should be slight and the applications frequent. Some authors report cases relieved by the use of a galvanic current of $1\frac{1}{2}$ to 2 milliamperes continued for 5 minutes. The cathode is applied to the lids or supraorbital notch, and the anode to the cheek. The method is worthy of a trial if others fail.

47. **Epithelial** and **parenchymatous keratitis** may be benefited by the judicious application of the constant current. It has been argued by some that the instances where electricity has proved successful are few and that the successful cases were probably in adults at which age the prognosis is generally favorable under any form of treatment. This may be met by stating that such complications as iritis, cyclitis, and vitreous opacities are observed in adults and that many of the successful cases occurred in children. Atropin and fomentations should never be omitted. In addition to faradization for the relief of photophobia and pain we should make direct applications of the galvanic current. The anode is placed upon the brow or cheek, and the cathode is attached to a small bit of fine sponge or a delicate sponge-tipped electrode of special pattern. The cornea should be gently brushed with the sponge, taking care not to break contact. The current should not exceed $1\frac{1}{2}$ milliamperes. A duration of 2 minutes is amply sufficient. Alternating with this treatment a constant current of greater intensity, say 2 to 4 milliamperes, may be given to the affected eye through the closed lid for 3 to 5 minutes. It is advisable to discontinue electrical treatment now and then and substitute applications of yellow-precipitate ointment. Sometimes general mercurial inunctions are serviceable. As the cornea begins to clear up, the intervals between electrical sittings may be lengthened.

48. **Neuroparalytic keratitis,** so called, may be relieved in some instances by the stabile and labile applications of a constant current of 2 to 5 milliamperes for short periods. The cathode-sponge should be the active electrode, and is applied to the closed lids. The anode is placed in any convenient site, as for instance the brow, cheek, or patient's hand. The proper moistening of the electrodes should never be neglected. It is perhaps wise to caution the operator to be on the watch for vesication at the site of the anode.

49. **Phlyctenular keratitis** is a concomitant of the corresponding disease of the conjunctiva, and calls for the therapeutic measures outlined in the section devoted to that subject. Atropin, yellow oxid-of-mercury ointment, calomel powder,

and fomentations constitute the ordinary treatment. It is in the ulcers resulting from the broken-down vesicles that treatment by electrocautery finds its limits of perfection. The method of application will be referred to later, when treating on ulcers of the cornea. Not merely is this agent recommended in superficial troubles, but also for purposes of paracentesis, together with use of eserin to guard against possible hernia of the iris. When one large phlyctenula or perhaps two or three smaller ones appear upon the cornea, the timely use of the electrocautery may prevent undesirable results. The vesicle or vesicles should be touched with the small, blunt cautery-tip brought to a white heat, pains being taken not merely to rupture the little sac but to bring the tip in contact with the base and margins. The indications are the same if the vesicles have already ruptured spontaneously. In obstinate cases where other means have failed, the cautery will solve the difficulty. Recurrent forms call for repeated applications.

ULCERS OF THE CORNEA

50. Infiltration, ulceration, and cicatrization are the stages through which most affections of the cornea must pass. Each stage may be more or less severe, depending on the nature of the process or on the exciting cause. It is not so much our province to inquire into the causes of these conditions as it is to promote healing and subsequently to remove any deposits, so far as we may. The ulcer may be superficial or deep, dry or purulent, serpiginous or rodent, marginal or central. These different types represent various characteristics of form, size, and rate of progress. Some are infective, others not, depending on the variety of cause, microbic or otherwise.

51. Treatment.—In general terms the treatment of all forms of ulcer is the same. The utmost vigilance is necessary, since some of the worst forms to deal with present the fewest symptoms and many are very rapid in their course. For pain, spasm, and lacrimation the faradic current, as before outlined, is commended. The instillation of atropin should not be neglected. A properly adjusted compress-bandage is valuable

in all forms of ulceration save the secondary types, where there is secretion to be drained. The surgical management of corneal ulcer does not differ materially from that of ulcers elsewhere.

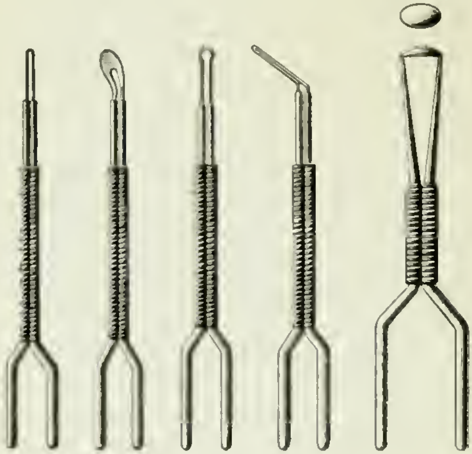

FIG. 33
Cautery-Tips for Operations on the Cornea

The indications are to remove all diseased tissue down to a healthy floor and to promote granulation thereon. The curette has been largely used and is valuable. More valuable, still, is the electrocautery. Some of the cautery-tips most commonly employed in operations on the cornea are shown in Fig. 33. A glance at Fig. 34 will show what is necessary to be accomplished. This represents a microscopic section of a cornea through an ulcer; *e* is the surface epithelium, *b* the anterior elastic lamina, *p* the posterior elastic lamina. The floor of the

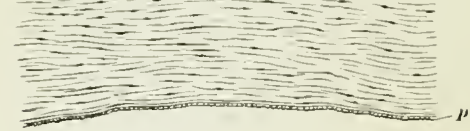

FIG. 34
Vertical Microscopic Section Through a Corneal Ulcer

ulcer is seen crowded with pus-cells and leucocytes. The cautery must clear up this floor and throw off any overhanging edges. See that the electrocautery-apparatus is working well. The operator will be guided in the selection of a tip by the requirements of the case. Regulate the current so that the tip is brought to a white heat instantly, if possible. If there be difficulty in ascertaining just how much tissue must be seared, apply to the eye a solution of fluorescin. This will stain all affected parts. The eye should be thoroughly cocainized. Bring the *unheated* tip carefully and rapidly to the parts, once for practice and then touch again with the cautery-tip brought instantly to a white heat. In simple superficial ulcer no further applications are necessary, as a rule. In suppurating, rodent, or serpiginous forms, we must be watchful for any extension or deepening of the process and check it by another touch of the cautery. Particularly rebellious or indolent ulcers may demand a second séance.

52. Where the ulcer has attained great depth and threatens to perforate the cornea, a different plan of treatment is adopted. Usually in this condition there is great pain, and the thin layer of cornea intervening between the surface and the anterior chamber may be seen to bulge. In these cases paracentesis or perforation of the cornea by the electrocautery is indicated. The curtain of the iris should be well drawn away from the field by atropin. The cautery-tip should consist of a narrow, sharp, platinum blade that will produce a small linear incision through the floor of the ulcer. The method is the same as given above, with the exception that the tip passes entirely through the cornea and permits the escape of the aqueous humor or any hypopyon that may exist. It is better to perform paracentesis without waiting for perforation to become imminent. It is good routine practice in all ulcers of considerable depth. Should we allow an ulcer to perforate, much tissue is lost and the resulting scar is large, whereas if we open the chamber in the manner indicated, there results but a narrow scar and slight opacity. Unfortunately, the surface epithelium and the elastic lamina are not reproduced in the process of

repair. There is usually some opacity of the cicatrix though it may be very slight in favorable cases. Electricity unfortunately has no place in the treatment of the synechia and prolapses that occasionally occur in neglected instances and sometimes complicate the operable cases. Some of the older writers treated corneal ulcer by faradism, stroking the ulcer with a hair-brush, which was made the cathode. The method has given way to a better one. The hypopyon so frequently associated with ulcer usually disappears spontaneously. Should it persist, its absorption may be hastened by applying a current of 1 to 2 milliamperes to the closed lids through the cathode-sponge once or twice daily for 5 or 7 minutes.

OPACITIES OF THE CORNEA

53. The treatment of opacity of the cornea, also called nebula or leucoma, is based on the hypothesis that mild stimulation of scar-tissue will promote absorption and favor the deposit of a tissue more normal in character. In the case of corneal structure this tissue is clear. Much time and effort have been spent in determining just what amount of stimulation is required to bring about the desired end without producing a reaction inflammatory in character. The character of the stimulus is also of importance. In galvanism we possess an available agent for the treatment of opacities. It is stimulating and is capable of very fine gradations in strength. Recent opacities, it must be borne in mind, respond much more rapidly to stimuli than old ones, so that in treating fresh cases we apply only the gentlest currents. The cathode is the active pole. The electrode may consist of a silver probe, or sound, or a bulb-tipped bougie. It should be rubbed very gently over the cocainized cornea near the scar-tissue while a current of $\frac{1}{2}$ to 1 milliampere is passing. Use always a low amperage, but gradually increase the time of the sitting. The eye may become injected and the conjunctiva flushed while the current is flowing, but this irritation is transitory and subsides within a few hours. The eye should be kept closed for half a day after treatment. The patient should receive attention as often as

every second day. The best results are looked for in opacities following interstitial keratitis, but scars from old ulcers clear up remarkably under the treatment. The margin of the nebula is the first to clear.

KERATOCONUS AND ANTERIOR STAPHYLOMA

54. These conditions, resulting usually from perforating ulcers, demand operative interference as a rule, particularly where associated with synechia and leucoma. The outlook for sight is poor indeed and frequently the patient gains an improved cosmetic appearance and little more. In simple keratoconus due to atrophy, fair results are obtained by creating an ulcer near the summit of the cone with the electrocautery lightly applied. The ulcer is placed to one side of the pupilary space, if possible, so that the resulting cicatrix will not blur the vision. Should a nebula result, it may be dispersed by galvanic stimulation, as previously mentioned. The results are usually good. The electrocautery is used in anterior staphyloma with leucoma, and is best applied with a narrow-bladed cautery-tip, as follows: Make a linear burn through the tissues down to the posterior corneal layer. The incision should extend from the upper to the lower margin of the cornea passing to one side of the pupilary opening. The results of this procedure warrant its further trial. Cautery operations possess great advantages in being entirely aseptic.

POWDER GRAINS

55. Powder grains, whether embedded in the cornea, conjunctiva, or eyelids, may be removed by the use of the electrocautery. The grains should be attacked soon after the accident, since if allowed to remain long they produce permanent staining. A very fine-pointed tip should be brought to a white heat and passed into the site of each grain, causing a slough large enough to include the particular grain. If the grains be in reasonable numbers, all may be removed by this method at a single operation.

DISEASES OF THE SCLERA

EPISCLERITIS AND SCLERITIS

56. Superficial and deep inflammations of the sclerotic coat have furnished the theme of animated discussions as regards the availability of electricity in their treatment. Galvanism and electrolysis chiefly have been used. Each method of treatment has found adherents. Operators who have practiced galvanization are not altogether agreed as to which pole should be the active one, some using the anode and others the cathode, applying the electrode directly to the conjunctiva in some cases and indirectly to the eye through the closed lids in others. It is not surprising that out of this confusion there should arise little or no uniformity in results.

57. The practitioners who have used electrolysis are quite in accord as to a scientific plan of treatment. A fine iridoplatinum needle is made the cathode and is introduced into the base of the circumscribed purplish patch or episcleritic button, beneath the conjunctiva. The anode is applied to the back of the neck or to the brow. A current of 2 to 3 milliamperes is permitted to flow for 1 minute. The eye should be completely anesthetized. One electrization is generally sufficient. We may supplement this treatment with transpalpebral electrization, placing the cathode to the closed lid, the anode to the brow or neck, and passing 2 to 4 milliamperes of current for 10 to 15 minutes. The general effect of this plan of treatment has been to induce a speedier termination of the inflammatory process. It is noteworthy, however, that it does not forestall a recurrence or prevent the circular march of episcleritis. New buttons are prone to develop. Together with the electrical, a routine plan of treatment should be used. Fomentations and leeches are very serviceable. The hygienic and constitutional care of the patient must receive due attention.

58. Deep inflammations of the sclerotic coat offer problems that up to the present, electrotherapeutics has not solved. Some of the German ophthalmologists have been successful in isolated cases by the direct use of galvanism. The electrode is of

platinum, flat or slightly concave at its extremity, and measures $\frac{3}{4}$ inch in circumference. It is made the anode and applied directly to the eyeball in the affected area. A current of 1 to $1\frac{1}{2}$ milliamperes is passed through the tissues for 1 minute. The treatment may be continued following an interval of 2 days. It is reasonable to suppose that the sedative effects of the positive pole should exercise a beneficial influence on the inflamed parts, but too often, unfortunately, the results of the treatment are unsatisfactory and disappointing.

DISEASES OF THE UVEAL TRACT

IRITIS AND IRIDOCYCLITIS

59. Inflammatory affections of the ciliary body and iris are not materially modified in their course by electrical applications. We must look rather to routine treatment with atropin and other agents to combat the process. As an aid to routine treatment, however, electricity has found a place. Chief among the results that it will contribute toward bringing about is the relief of *pain*, *photophobia*, and *spasm*. Where these symptoms are intense it will be found that the patient will experience marked relief from faradization, applied with a small sponge-electrode directly to the cornea or through the closed lids with large electrodes. Again, the finger tip of the physician may be made the active electrode and the closed lid gently stroked. The strength of current should in all cases be determined by the sensibility of the patient. Better results are gained by using weak currents for a considerable period of time at each sitting, half an hour or longer. The period of relief appears to depend on the length of time of the sitting. The pain will return, as a rule, after a variable period of quiescence, but yields to repeated faradization. Occasionally, cases rebellious to faradism will be influenced by galvanism. In such instances the anode is to be applied to the closed lids in the form of a broad, moistened electrode and a current of 2 to 3 milliamperes is permitted to pass for a period of 2 to 3 minutes. Faradization, however, will generally accomplish all and more than we may expect from other sources.

60. Electricity finds further utility in this class of cases in *promoting the action of mydriatics and myotics.* In some forms of iritis, particularly of a plastic type, where atropin and eserin fail to produce effect on the pupil, negative cataphoresis will prove serviceable. With the mydriatic or myotic instilled into the eye, apply a constant current of 2 milliamperes to the closed lids. The cathode is made the active pole and the anode is placed on the back of the neck. The duration of this treatment should be from 15 to 30 minutes, in order to obtain the best results. This plan should be used first with atropin and then with eserin.

61. *Absorption of exudates* is hastened by judicious electrical manipulation. Simple hemorrhage into the anterior chamber of the eye seldom requires particular attention. The hemorrhage and purulent exudates resulting from iritis, which fill both chambers of the eye, are often very slowly absorbed. This is the class of cases where we may expect benefit. The treatment is the same as that previously given, with the exception that the mydriatic may be omitted, if desired, and the duration of the application need not exceed 5 minutes at each sitting. The interval between periods of treatment need not be long, 24 hours being amply sufficient. Faradism has been used in iritic hemorrhage, but it is valueless in all cases of intra-iritic bleeding and is available only in simple hyphemia, which condition, also, no doubt, is little influenced by it. Its greatest utility lies in the control of pain and spasm.

62. Disseminated choroiditis has been treated by the application of constant currents of mild strength and indifferent polarity through the temples or from the supraorbital notch to the mastoid process of the same side.

DISEASES OF THE VITREOUS HUMOR

63. Opacities. — The treatment of vitreous opacities should aim toward the removal of the cause. Specific etiology calls for appropriate constitutional treatment. Local measures generally include leeching and the use of pilocarpin. In the management of opacities of whatever cause, electricity will serve

as a valuable adjuvant. Used alone it frequently fails in its mission. The best results are to be attained by the employment of the stabile constant current of 2 to 4 milliamperes passed either directly through the closed lids to the mastoid process of the same side or through the temples. The poles should be changed frequently. It is well to begin with the anode to the eye and reverse the current during the sitting or at the subsequent visit. Daily applications of 2 to 4 minutes are desirable. It is claimed for faradization that the results of its use are fully equal to those obtained by the method just referred to. We are convinced, however, that galvanism will yield the more satisfactory effects in the general run of opacities resulting from promiscuous causes.

DISEASES OF THE RETINA AND OPTIC NERVE

RETINITIS

64. In view of the claims put forth by the older writers regarding the beneficial effects of electric currents applied to the cervical sympathetic in retinal disease, Rockwell undertook certain experiments in order to ascertain what changes, if any, were produced in the normal retinal circulation by galvanization and faradization of this nerve. In substance, his conclusions were as follows:

1. Galvanism and faradism to the cervical sympathetic may cause contraction of arteries and dilatation of veins.

2. Faradism causes the same effect as galvanism, only more slowly, it being a difference in degree rather than kind.

3. Mild currents and brief applications produce contraction of vessels; strong currents and long applications cause dilatations. Much depends on the temperament and condition of the individual experimented on. What would cause dilatation in one would produce contraction in another.

4. Where the patient is excited or irritable even a mild current may cause dilatation at once.

5. The contraction that takes place is sometimes followed by a dilatation beyond the normal.

6. The dilatation that occurs is followed by a contraction after the close of the experiment.

65. From these experiments it is gathered that while the results of electrical stimulation of the sympathetic are indefinite and unstable, nevertheless there occurs a considerable alteration in blood-flow in each instance. Therefore, as a factor in restoring nutrition to a deceased part, it is valuable. So much controversy has arisen in regard to the utility of this method of treatment that the fairest way to judge of it is by comparative observation of results. If the method be used alone, no good may be expected to accrue. If, on the other hand, it is used in conjunction with other methods, it may be serviceable. This fact is borne out by an investigation of the results of a combined form of treatment. The cases most amenable to electrical methods are those of a *hemorrhagic type*. Albuminuric retinitis gives us less satisfaction. In glycosuric retinitis, with or without scotoma, and in retinitis *pigmentosa*, a combined plan of treatment will serve well. Too much must never be expected from any plan of procedure. The pathology of retinitis shows us plainly enough what a discouraging task lies before us. We may frequently bring about some slight improvement or, at least, arrest the progress of the disease and improve the vision. These ends are worthy of effort.

66. What is meant by a combined treatment will be explained. Stimulation of the cervical sympathetic nerve on the same side as the affected eye alternates with the application of the constant current directly to the eye. This method is as follows: A broad, flat plate, well padded with moistened absorbent cotton, is placed on the back of the patient's neck. The plate is made the anode. The cathode should consist of a dull or probe-pointed metal electrode attached to a handle having a make-and-break arrangement. The cathode is pressed into the soft tissues of the neck in the region of the superior cervical ganglion. A current of 2 to 10 milliamperes may be allowed to pass for a period not longer than 3 minutes. The current may be interrupted several times, if desired. On alternate days the continuous current may be applied directly to

the closed lids. The cathode is the active electrode. A current of 1 to 2 milliamperes should be administered for 5 minutes. This plan of treatment, together with hygienic and constitutional care of the patient, should continue with occasional intermissions for months, or until signs of improvement in the appearance of the fundus and in the patient's vision are manifest.

SEPARATION OF THE RETINA

67. The prognosis in this serious condition is sufficiently unfavorable to warrant affording any rational plan of treatment a trial. Medication is useless. A few instances of spontaneous repair are on record, but this fortunate outcome is never to be relied on. Operative attack has more supporters than any other method. While apparent relief in some cases has followed nearly every variety of operation, it must be understood that no one mode of procedure will suffice for all cases. The same holds good in treatment by electricity. While electrolysis of the subretinal fluid has been successful at times, it has failed at others, and electrocautery-puncture has shared the same fate. Since each of these electrotherapeutic measures has acted favorably, it will be well to speak of each in more detail.

68. The electrolytic needle is used on the principle that sanctions its employment in cases of nævi, aneurism, and hydrocele. There exists between the retina and choroid a collection of fluid that we desire to subject to the electrolytic action of the anode. A suitable needle is requisite. It should be of iridoplatinum, insulated to within 3 millimeters of its tip, at which point a shoulder should project so as to prevent the needle penetrating too deeply into the tissues. This needle is fitted to any convenient round holder and is made the anode. The cathode is to be applied to the back of the neck. The needle is passed through the tunics of the eye with a gentle back-and-forth, rolling motion between the fingers, so as to avoid pressure. The site of introduction should be as near the center of the detachment as possible. The current is gradually raised from 0 to 5 milliamperes and gradually reduced to 0; it is

applied for about 1 minute. A second operation of this character may be performed after the expiration of a fortnight's rest. Some specialists prefer to use bipolar electrolysis, in which case two needles, similar to the one described, are mounted $\frac{1}{8}$ inch apart in an insulated holder. The best results attained are in recent cases.

69. Electrocautery puncture may be single or multiple. The method has the advantage of avoiding choroidal hemorrhage, of being perfectly aseptic, and affording drainage. The operator should possess a fine, rounded, platinum cautery-tip, the shank of which is curved, or bent, to an angle of about 45° to the holder. The site of puncture selected should be as near the equator of the eyeball as possible and equidistant between any two recti muscles. The site will necessarily vary, however, with the position of the detachment. The cautery-tip heated to a white heat is brought to the field of operation. The cocainized eye is steadied by mouse-toothed forceps and the tip is made to burn its way through the coats of the eye into the subretinal space. The instrument should be held in place until a perfectly round hole is formed. More thorough drainage is assured by searing a second or even a third hole into the space near the margin of the separation. The tendency of the separations to recur, owing to the filling of the space through a retinal rent, is in a measure obviated by this plan of treatment.

70. Traumatic anesthesia of the retina is best treated by labile cathode applications of galvanic current to the closed lids.

OPTIC NEURITIS AND ATROPHY

71. The older writers taught that galvanism should be used in all cases, whatsoever the cause. They used the anode to the eye in early stages, and the cathode in the later stages. The currents were weak and the length of applications short. Galvanic currents were also passed through the temples and from before backwards. Considerable enthusiasm prevailed, and

one experimenter taught that fully 50 per cent. of cases of white atrophy were improved. It is probable that this figure was inspired, partially at least, by an overconfidence in a new remedy. The consensus of opinion among the more recent workers is that electrotherapeutic measures are valuable in selected cases only. In optic neuritis of whatever cause, little is to be expected and nothing is gained in the treatment of atrophy due solely to this cause. Simple uncomplicated atrophy may exhibit all indications of arrested progress, while secondary atrophy, due to embolism, syphilis, or retinitis pigmentosa, may be improved by electrization in conjunction with treatment directed to the removal of the cause.

72. The means at our disposal that will accomplish most in the treatment of atrophy are threefold:

1. Local transpalpebral galvanism, the anode to the back of the neck and the cathode to the closed lids. A current of 2 to 4 milliamperes should flow for 2 to 3 minutes.
2. At the subsequent sitting a constant current of equal strength may be passed transversely through the temples for a longer period of time.
3. Occasional galvanization of the cervical sympathetic with a moderate current, placing the anode on the nucha and the cathode over the superior cervical ganglion.

GLAUCOMA

73. Coincident with routine measures and iridectomy, galvanization of the cervical sympathetic is valuable. We desire the sedative action of the current that acts similarly to a division of the nerve. The cathode is applied to the nucha while the anode is placed along the course of the nerve. A current of 12 to 20 milliamperes should be kept flowing for 2 to 5 minutes. The effects are observed promptly. Restlessness and pain are relieved. A palpable diminution of intra-ocular tension, even in cases of simple chronic glaucoma without iridectomy, will occur and improvement of vision is to be expected.

OCULAR PALSIES AND ASTHENOPIA

74. It is essential in attempting to treat paralysis of the muscles of the eye that we have a correct understanding of the conditions that confront us. One muscle alone may be affected or one nerve that controls a number of muscles. Again, several nerves may be implicated simultaneously. We judge of the position of the lesion causing the paralysis by the grouping of symptoms. For instance, if the internal rectus of one side and the external rectus of the other are affected, we look for the lesion near the nuclei of origin of these nerves or outside the orbit. If the internal rectus of one side alone be paralyzed, we judge that the lesion is in the filament of the third nerve supplying that muscle and is inside the orbit. The character of the lesion is of importance, also. A gumma producing pressure upon a nerve is more amenable to relief than a glioma. In some muscular affections elsewhere in the body electrodiagnosis will serve to clear up conditions sometimes, but in ocular paralyses we have no recourse to it. The main feature in the treatment is the direct excitation of the paralyzed muscle or muscles. Galvanism or faradism may be used. As a rule it will be advisable to make use of both forms of current. The cathode is the active electrode where the former is used. Some practitioners make use of a large moist compress laid upon the closed lids upon which the cathode terminal electrode is placed. It is our belief that better results are to be gained by using small olive-tipped or ball-pointed electrodes. These may be pressed deeply into the conjunctival sac close to the insertions of the muscles. They are available for either galvanization or faradization.

75. Treatment.—The plan of treatment is as follows: The anode is placed to the temple of the side to be treated; a large button-electrode is serviceable. The cathode, in the form of the ball-tipped sound, is thrust deeply into the conjunctival sac in the direction of the insertion of the injured muscle. The current is now turned on, gently at first. By means of an interrupter in the circuit, generally in the handle of the electrode, the operator may close the circuit at will and observe

the resulting contraction. It may be well to judge of the strength of current necessary by watching that which will excite a healthy ocular muscle to contraction. A somewhat stronger current is requisite for the paralyzed muscle. A few contractions, however slight, are sufficient for the first sitting. Longer applications may follow later. As a general rule, the treatment may be given daily. Faradization should alternate with galvanization. The same electrodes may be used. It is well to change the polarity frequently during the faradic séance.

76. Muscular asthenopia, especially with hyperesthetic retina, is a condition that frequently yields most readily to electrization. Mild faradic currents are efficacious, given labile with the anode to the closed lids. The position of the cathode is immaterial. The continuous current is also serviceable. One to 2 milliamperes should be passed through the closed lids for 5 to 10 minutes, changing the polarity once or twice. It is well to alternate the two forms of application.

77. Accommodative asthenopia calls for rest, general treatment, and daily galvanic sittings. The cathode is applied to the closed lids, and a current of 2 to 5 milliamperes is passed for 2 or 3 minutes. Stroking the closed lids with the terminal wire thickly wrapped in moist cotton serves favorably. Mild labile faradizations may properly alternate with the galvanism.

78. Functional hemeralopia is alleviated by mild faradization to the closed lids with the cathode as the active electrode. Daily sittings of 5 minutes each are sufficient. Binocular galvanism with indifferent polarity has been recommended, but the results are slower in appearing, and we are convinced that faradization offers better general effects.

OCULAR NEURALGIAS

79. For the relief of those obstinate and painful affections known as **ocular neuralgias,** no means not directed toward a removal of the exciting cause will yield permanent results. Paroxysms of distress may be quickly quieted by the sedative

action of the galvanic current, but the respite is only temporary. A current of 2 to 6 milliamperes should pass through the tissues of the lids, brow, and face from the anode terminal. The cathode may be placed on the mastoid or the neck. The duration of the galvanization should occupy about 5 minutes.

VASCULAR TUMORS OF THE ORBIT

80. The general rules laid down for the treatment of **vascular tumors** of the lids and face apply equally well for similar growths in the orbit. Electrolysis offers a safe and efficient means for removal and one that does not disfigure. The bipolar method has received the sanction of the majority of operators and is the best. The needles should be of irido-platinum and lance-pointed. Curved needles may be serviceable at times. They will require insulation to an extent varying with the requirements of each case. A coating of shellac or collodion will furnish all insulation necessary. Where the tumor is small the needles may be mounted in an ordinary bipolar handle, but where the growth has attained some magnitude it is better to use two needle-holders. The cathode needle may be inserted into the tissues of the mass and allowed to remain in one spot while the anode is passed in various directions at one operation. It will not be amiss to repeat a word of caution in regard to insulating the needles sufficiently to guard against electrolyzing the tissues other than those composing the tumor. It is difficult to fix definite limits to the strength of current to be used. The practitioner must be guided largely by the individual case. Generally speaking, the current should not exceed 15 milliamperes, and the time of application need not go beyond 10 minutes. An interval of several days should elapse before electrolysis is repeated, if a second operation is deemed essential.

LOCATION OF FRAGMENTS OF METAL IN THE EYE BY MEANS OF X-, OR ROENTGEN, RAYS

81. Hand in hand with the improvements in apparatus, the technique of locating pieces of metal in the orbit has advanced so that at the present time experts are able to determine their position with mathematical certainty. The tissues of the eyeball itself offer great resistance to the passage of rays, and this resistance is naturally increased by the bony framework of the orbit. The eye is so situated that no exposure can be made without including some of the neighboring bones, and the problem that confronts us is to reduce the bony shadows to a minimum. It has been determined by experimentation that the path of least resistance lies in a line passing across or partly through the nasal bones and through the orbit to the temple. Anteroposterior and vertical exposures are inadequate. The source of the rays must start from the side opposite the injured eye, and the skiagraphic plate should be attached to the temple adjacent to the injured eye. In this manner the clearest skiagraphs are obtained. The greatest manipulative skill is necessary in this work and no one not an expert in Roentgen ray methods should attempt it. It will be unnecessary to give in detail all the modifications of procedure, but one of the best methods will be outlined rather explicitly. The method is that of Dr. Wm. M. Sweet, of Philadelphia, to whose writings* we are indebted for material and illustrations.

82. The tubes that generate the rays should be of high-vacuum pattern with resistance sufficiently low to avoid interruptions of the rays and allow a steady generation. Fig. 35 shows a Queen's self-regulating tube that operates in the following manner: The larger tube has a high vacuum and offers high resistance. The smaller tube is one of moderate vacuum that has leading into it from the larger tube a bulb containing potassium hydrate. Leading to the smaller tube is a hinged metal rod *B*. It is also provided with a cathode-terminal from

*Trans. Amer. Ophth. Sec., Vol. VIII, Pt. 1, Page 91.
Arch. of Ophth., Vol. XXVII, No. IV, Page 377.

which the current jumps to the bulb, heating the potassium hydrate until it gives off gas, which lowers the vacuum in the large tube. As the potash cools the gas is reabsorbed. *A B* is a spark-gap, usually adjusted to 4 inches, across which the charge occasionally passes and maintains a steady vacuum in the larger tube. An induction-coil is used, which is supplied by the ordinary constant-current lighting circuit, controlled by a rheostat.

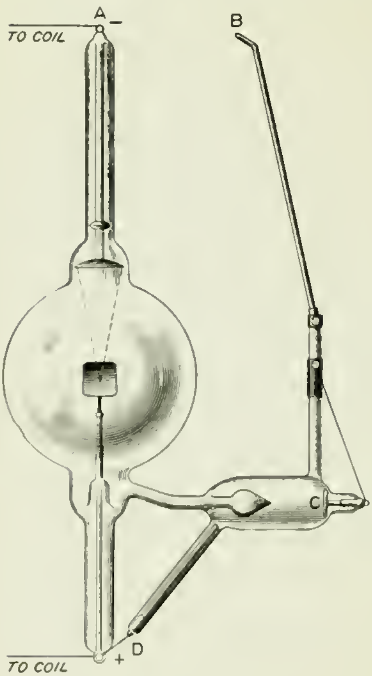

Fig. 35
A Crookes Tube of Special Pattern for Eye-Work

83. To assist in locating the foreign body, two parallel, ball-tipped, metallic indicators are used. These indicators are at a given distance apart, one pointing directly to the center of the cornea, the other to the temporal side of the eye. The site of the body is calculated by means of the relations between the shadows of the body and the indicators. Two exposures are necessary, one with the tube horizontal, in the plane of the indicators, the other at a distance below it. Fig. 36 is a diagrammatic scheme of the principle. Letting the candle-flame represent the Crookes tube, the surface *C* represents the shadows of the indicators and body on the photographic plate when the tube is in the first of the two positions spoken of *A*. When the tube is in the second position *B*, the shadows are thrown on the plate as shown on the surface *D*. If we know the distance of one indicator from the cornea, which may be regulated by the operator, and that between the indicators, which is fixed, the position of the metal body may be calculated, because its

shadow maintains fixed relations with the shadows of the indicators, no matter in what position the tube is placed. It is necessary also that the indicators be parallel with the axis of the eyeball and parallel to the skiagraphic plate. These requisites have been conveniently combined, as shown in Fig. 37. The patient is placed in the prone posture during the exposure. Two radiographs should be taken, as above indicated. Four minutes is a sufficient length of time for each exposure.

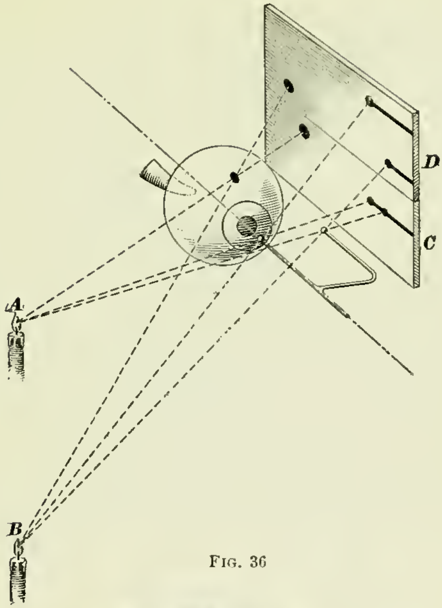

Fig. 36

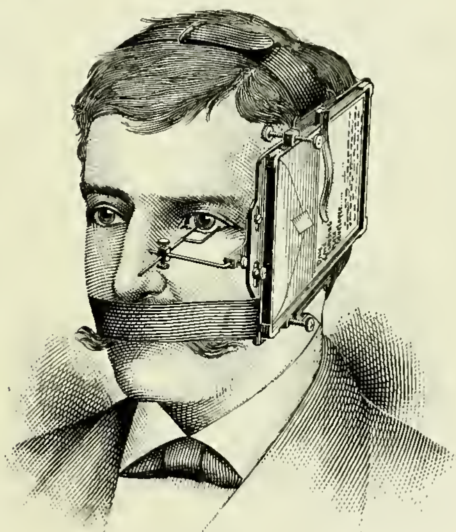

Fig. 37
Showing Position of Plate and Indicators

84. Let us now suppose that we have the skiagraphs showing the shadows of the body and indicators (see Figs. 38 and 39). The distances between the shadows of the body and indicators are to be measured in each, as well as the distance of the body

Fig. 38

Skiagraph Made With Tube at A, Fig. 36

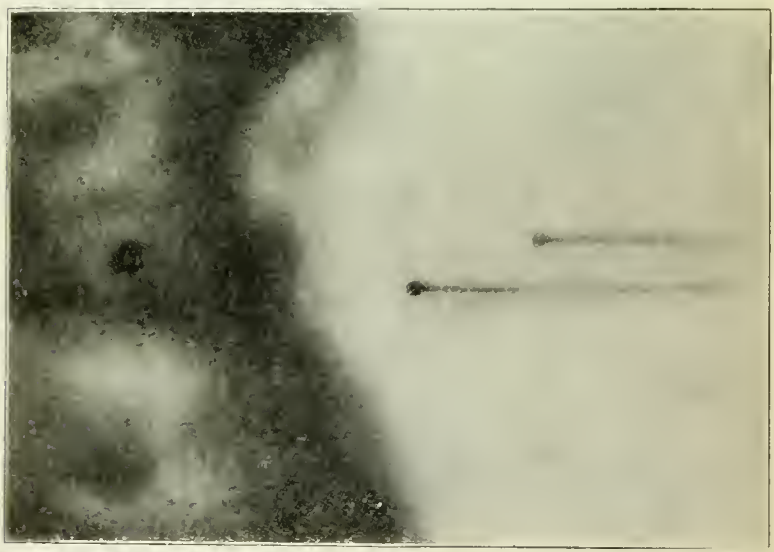

Fig. 39

Skiagraph Made With Tube at B, Fig. 36

above or below the indicators. For convenience sake, these relations may be outlined as shown in Figs. 40 and 41.* Now, to ascertain the position of the body in the eye, draw on paper two circles, each 24 millimeters in diameter. Let the lower one represent a vertical section of the eye and the upper one a horizontal section (see Fig. 42). The point A at the center of the vertical circle represents the center indicator, and the point B, the temporal indicator. The line $A\ B$ is the exact distance between the indicators. On the horizontal circle a point is made

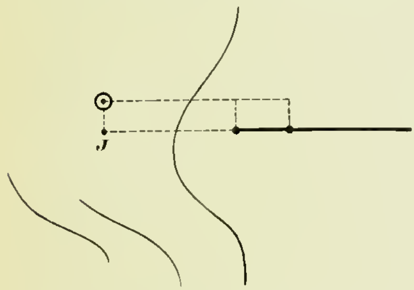

FIG. 40

Schematic Representation of Fig. 38

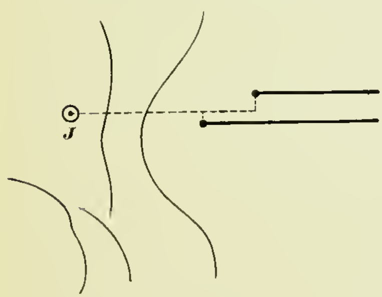

FIG. 41

Schematic Representation of Fig. 39

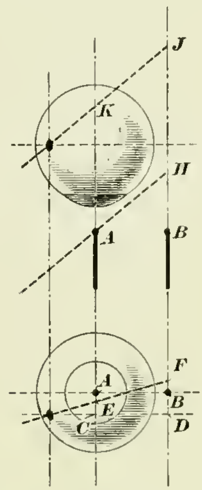

FIG. 42

in front of the center of the cornea at a distance equal to that between the indicator and the center of the cornea at the time of the exposure. A and B will represent the indicators, and $A\ B$ the distance between them. The distances of the shadows of the body above or below the indicators, $A\ C$ and $B\ D$ in the

*In order to understand the relative positions of the shadows belonging to the indicators and the foreign body, it should be remembered, that when a photographic print is taken of a skiagraph the left side is changed to right and vice versa.

one case and $A\,E$ and $B\,F$ in the other, are marked above and below the points of the indicators in the vertical section. In the diagram they are below in each case. The line $C\,D$ shows the direction of the rays at the first exposure, and $E\,F$ the direction of rays at the second exposure. The intersection of these lines marks the site of the foreign body with reference to the temporal or nasal side and above or below the horizontal plane of the eyeball. Now mark above the external indicator on the horizontal diagram the measurement of the distance between the shadows of the two indicators, as shown in the horizontal exposure. Draw a line from this point H through the center indicator. $A\,H$ is the line showing the direction of the rays. The distances from each indicator, on the same exposure, to the shadow of the body are to be marked on the same diagram perpendicular to A and B. These points are K and J. The line $J\,K$ shows the plane of the shadow of the foreign body, and the point of intersection of that line with another perpendicular to the position of the body, as found in the vertical section, marks the position of the body in relation to its distance posterior to the cornea. With, therefore, the relative distances of the foreign body in millimeters or fractions of an inch, it becomes a much simpler matter to attempt its extraction. No complications resulting from exposures to the Roentgen rays beyond a transient dermatitis can be said to arise.

REMOVAL OF PARTICLES OF IRON OR STEEL FROM THE EYE BY THE ELECTROMAGNET

85. Pieces of iron or steel that have found lodgment in the conjunctival sac may be easily removed by the use of the spud or by the electromagnet. Where particles have penetrated the tunics of the eye itself, the affair assumes a much more serious aspect. The magnet may be successful in removing the foreign body but several requisites are necessary. The magnet itself must be powerful enough to dislodge the particle from the tissues in which it may be embedded. The magnet must be brought as near as possible to the fragment. If the tip of the magnet can be introduced through the wound of entrance, so

much is gained; but if the wound is not large enough, it must be aseptically enlarged or a point of entrance made if none be visible or accessible.

86. For ordinary use, Johnson's portable magnet is serviceable. The instrument is $7\frac{1}{2}$ inches long. It is wound with 2 pounds 10 ounces of No. 27 single, silk-covered, magnet wire. The total weight is $3\frac{1}{2}$ pounds. Two tips are provided, one ovoid in form and $\frac{1}{2}$ inch long, the other elongated, having a diameter of $\frac{3}{32}$ inch. This magnet has sufficient internal resistance to permit its excitation with the ordinary 110-volt current. Hirschberg's magnet, Fig. 23, is quite powerful, and is the one most frequently used in the extraction of steel particles that have penetrated the eye. The apparatus comprises the magnet and several adjustable tips of different forms. Haab's magnet, Fig. 24, is the most powerful of all. It consists of a soft-iron cylinder 60 centimeters long and 10 centimeters in diameter, terminating in a conical tip at each end. This core is surrounded by a coil of copper wire 5 centimeters thick. The instrument turns on a vertical pivot. It is excited by any source of constant current, provided the voltage is somewhere between 60 and 120. In connection with the circuit before the apparatus, is a bipolar interrupter and a safety arrangement. The conical tip is brought as near the particle to be removed as possible. To this end the patient is generally brought to the instrument in a high chair in such a position that the tip is just in contact with the wound of entrance or with the embedded particle. The extraction of foreign bodies by this method is quite painful, as a rule.

ELECTRIC OPHTHALMIA

87. Before closing the subject of the electrical treatment of diseases of the eye, it may be well to mention a disorder produced by the effects of electric light. **Ophthalmia** is never due to the ordinary use of the incandescent lamp, and we must look to the more intense forms of the electric light, such as the arc-light, for the exciting cause. Some electricians and employes who are obliged to work near a cluster of arc-lights will suffer from the results. The disease occurs chiefly among electric

welders, whose vocation necessitates exposure of the eyes to an intense glare.

The symptoms are almost identical with snow-blindness. They appear promptly after exposure, as a rule; usually within a day. The pupils are contracted, and the lids may be swollen and the seat of some edema. During the course of the affection there is usually a slight mucopurulent discharge from the conjunctiva. Recovery is expected within a few days. The rule is that vision is completely restored after the subsidence of all symptoms, yet rare exceptions show that occasional impairment may occur. A persistent central scotoma is an occasional sequel.

RETINAL BLINDING

88. Retinal blinding is the same affection as the blinding by sunlight. Certain experiments go to show that electric lights can produce changes in the retina without heat-coagulation. The changes referred to consist principally of edema with some destruction of nerve-cells in the outer layers, including the rods and cones. The inner layer of nerve-fibers may escape or may be involved as well. The harmful action of the light is attributed to a dazzling of the retina and to the chemical action of the ultraviolet rays. The heat rays may also have some influence.

The treatment is that for snow-blindness. Yellow goggles are useful, or combinations of red and dark blue may be substituted.

DISEASES OF THE EAR

INTRODUCTION

89. The earlier investigators in electrotherapeutics, with reference to diseases of the aural apparatus, were enthusiastic in their praise of the efficacy of the treatment. The literature is full of the results of their labors, but one must search quite in vain for the teachings of modern authors on the subject. It is a fact too often noted in the employment of an agent that after a full swing toward the side of utilization the pendulum vibrates as far toward the side of neglect. The present time

seems to be synchronous with the latter movement. An interval of time, which shall be devoted to a sober consideration of the value of a remedy, will be necessary to restore a middle ground between the two extremes. Positive opinions, therefore, as to the availability of electrotherapeutics must be held in abeyance until a more systematic effort has been made to place it in a sphere wherein its deserved merits will be attested.

90. Before entering upon a discussion of the various diseases of the ear toward which the treatment is aimed, it will be advisable to sound a note of warning as to the limitations of the subject. To begin with, we are aware of the depth of the parts beneath the surface and of their inaccessibility, the close association of the auditory nerve with the nerve of motion to the facial muscles, and the relations of the organ to the pharynx. Such an arrangement of structures demands for the relief of disease the application of principles based on the fullest appreciation of the physiology and pathology of the tissues. The laws applicable to the reaction of nerves to electric stimulation apply to this nerve of special sense in a characteristic manner but within definite and prescribed limits. The effects of such stimuli are shown in subjective sensations of sound and not by movements of muscles, as is the case with motor nerves. The ear has a double function, that of hearing and that of equilibration, and it is difficult to influence the nerve-filaments that govern one function without, at the same time, producing effects on the other, since these filaments together constitute the trunk of the nerve. Too much must not be expected of electric treatment directed to diseases of the nerve itself. It is in conditions affecting the external and middle portions of the ear that electrotherapeutics finds its chief utility. We make use of galvanism, faradism, static electricity, and electrolysis. The Roentgen rays are valuable in locating foreign bodies in the deeper portions of the auditory tract, where ordinary illumination is of no avail.

AFFECTIONS OF THE EXTERNAL EAR

ABNORMAL DRYNESS OF THE CANAL

91. Where the abnormal dryness of the canal is due to a lack of secretion of cerumen, it is benefited by recourse to the following procedure: Under a clear illumination of the passage with the reflector and speculum, gently remove all flakes of dried secretion and cleanse the parts thoroughly with warm water and the syringe, if necessary. Place the patient in a sitting posture beside a table, with the head pillowed sidewise upon it, the ear to be treated being uppermost. Fill the canal with normal salt-solution. Place the anode, in the form of a broad, well-moistened pad, on the patient's neck. A probe-pointed electrode of any pattern or the terminal battery wire, itself, will serve as the cathode, which is to be immersed in the water in the ear to the depth of ½ inch. Throw sufficient resistance into the circuit beforehand so that no reading is to be had from the milliammeter, and when the cathode is in position, gradually allow the current to augment until 2 or 3 milliamperes is attained. Continue the electrization for 4 or 5 minutes, gradually withdraw the current, and remove the electrodes. Allow the salt-solution to drain away, and wipe dry the external portion of the canal. This treatment may be repeated three times a week until the speculum shows a decided improvement. It is to be borne in mind that the current should never be of considerable strength when the cathode is serving as the active electrode, for reasons that will be apparent when we come to consider the effects of electricity on the auditory nerve, and that all abrupt fluctuations of current should be avoided.

92. To promote the *action of cocain* in anesthetizing the external passage and the drum, the constant current is of service. Place the patient in the posture just described, and fill the external ear with a fresh solution of cocain of 10-per-cent. strength. The cathode is placed on the patient's neck or over the mastoid on the side to be treated. A padded disk or

cup-shaped electrode will serve the purpose. The anode consists of a probe-pointed metal electrode, which is partially submerged in the cocain-solution. A current of 4 to 5 milliamperes is gradually attained and permitted to flow for 3 or 4 minutes. At the end of that time the anesthesia will be found to be complete, as a rule, and the current should be checked and the electrodes removed. If it is desirable to keep the patient in the same position for operation, the cocain-solution may be removed by cotton swabs.

STENOSIS OF THE EXTERNAL AUDITORY CANAL

93. Partial or complete occlusion of the external canal may be due to a variety of causes, on which depend the choice of agents for its amelioration and the methods of their application. The narrowing that results from *cicatricial contraction* following a local ulceration, or otitis media, will yield to cathodal electrolysis properly applied. On the other hand, a stricture due to *organized inflammatory deposits* calls for the particular electrolytic effects that the anode affords. The same may be said of narrowing due to *vascular growths*, or *nævi*. Malignant tumors are seldom the cause of stricture in this situation.

Electricity is of no avail in the treatment of stenosis due to congenital malformations. Electrical treatment should give way to surgical measures wherever, in the opinion of the operator, more permanent improvement is to be derived from it. In ordinary cases, however, electrolysis will serve the purpose to a better advantage.

In cases of *annular strictures* complicating or resulting from otitis media, the treatment by incision or excision of the ring, followed by the use of tents, should not be used. The tents cause constant suffering and are conducive to foulness and sepsis. The discharges are dammed back by them and their use is frequently followed by mastoid complications.

94. Electrolysis affords a safe, clean, and reliable agent for the treatment of such conditions. The ear may be anesthetized by the plan previously referred to, or the patient may decline all analgesics. A general anesthetic is scarcely necessary. The

operator will require a flat, well-padded, and moistened electrode to serve as the anode, and a needle of iridoplatinum of convenient length, which may be made the cathode, or active electrode. Place the anode on the back of the patient's neck. With the auditory canal well illuminated and the patient's head steadied at a height convenient to the eye of the operator, the needle is passed into the tissues composing the ring at a distance of about $\frac{1}{4}$ inch from the lumen. It is desirable to commence at a definite point, so that we may progress entirely and regularly about the periphery with punctures at subsequent sittings; in this manner the entire mass is attacked with system. The current should now be gradually raised until the milliammeter registers 4 or 5 milliamperes. This strength is to be maintained for 4 or 5 minutes and then slowly reduced to zero.

FIG. 43

Circular and Longitudinal Sections of Aural Stricture Showing Plan of Attack

The needle is then withdrawn and a light dressing of acetanilid or nosophen with aseptic gauze applied. There is, ordinarily, only a very slight inflammatory reaction following the treatment, and this quickly subsides. It is needless to state that the ear should be rendered as nearly aseptic as possible before the operation. Treatment may be continued after an interval of 2 or 3 days.

Fig. 43 shows vertical and horizontal sections of the stricture, with the needle in position and the dots indicating the location of the electrolytic punctures. By the time the entire circumference has been subjected to electrolytic treatment, the lumen of the passage will be found to be materially enlarged.

DISEASES OF THE MIDDLE EAR

OPACITIES OF THE TYMPANUM

95. Good effects are obtained by the use of a constant current after the manner indicated under the heading Abnormal Dryness of the Canal. An exception may be made as regards the polarity since, in drum opacities, we may gain better results by changing poles either during the sitting or at alternate sittings. Weak currents are desirable, and a strength of more than 2 milliamperes is not required. The treatment should cover an indefinite period of time, or until signs of improvement in the appearance of the tympanic membrane are marked.

OTITIS MEDIA

96. As an adjunct to the routine and systematic treatment of otitis media, electricity is of value. It cannot be said for it that it is in any sense curative, but that mild constant currents exercise a stimulating effect on chronic ulcerative processes and indolent suppurative conditions of the ear, cannot be denied. The affected ear is first thoroughly cleansed and freed from all discharge. A pin-point aperture in the drum is to be enlarged, so as to permit free drainage and douching. With the ear filled with saline-solution, the cathode is partially immersed and a current of 1 to 2 milliamperes allowed to flow for 1 minute. An aural metal sound, wrapped in cotton or left bare, will serve as the active electrode. The poles may be changed occasionally to advantage. Weak currents for short periods is the rule. Gentle swabbing of the parts, under illumination, with the cathode wrapped with cotton may occasionally take the place of the procedure already referred to. Topical applications of any character may follow the electrization.

97. The deafness that is due to an old middle-ear disease with *ankylosis of the ossicles* is occasionally relieved by faradism. This form of electrization is available on account of its mechanical effect on the bones. The electrodes and the mode of

application are the same as in otitis media. The interrupted current should never be strong. The patient may even complain, during the administration of very mild currents, of unpleasant reflex phenomena, such as dizziness, due to a disturbance of the semicircular canals, and a cough, due, possibly, to a stimulation of Arnold's nerve.

Static sparks may be used, and not without advantage, in ear-diseases where the bones are undergoing ankylosis but where the union is not yet firm.

98. The affections of the Eustachian canal, while falling properly under the section devoted to diseases of the ear, will receive consideration when we come to discuss diseases of the throat.

DISEASES OF THE INTERNAL EAR

99. The entire subject of the electrical treatment of diseases of the internal ear needs careful study. From a review of the evidence before us we must conclude that it is of little avail beyond a limited utility in some of the forms of tinnitus and deafness. By virtue of the effect of an electric current on the eighth nerve, under normal conditions, we are able to obtain some light as to the state of the nerve itself. The nerve possesses a normal degree of excitability that may vary or become altered by disease. For instance, drum-perforations and some forms of labyrinthine diseases lead to an abnormal degree of excitability—a pathological increase. On the other hand, some forms of diseases of the labyrinth lead to a pathological diminution of excitability and point to neuritis, particularly if accompanied by tinnitus. The electric current gradually increases the excitability of the nerve. All shocks are decidedly harmful. A stimulation of the nerve results in subjective sounds, a fact that is utilized by practitioners as an aid to *diagnosis* in aural affections. If we place one electrode on the patient's neck and the other on the tragus of one ear, and allow a current of 4 to 6 milliamperes to pass, we shall obtain different sounds, depending on the interruptions of the circuit. The character of the sounds may be buzzing, roaring, or whistling.

100. The behavior of the eighth nerve corresponds to the requirements of Pflüger's law: "A nerve is excited by the appearance of catelectrotonus and the disappearance of anelectrotonus, but not by the appearance of anelectrotonus or by the disappearance of catelectrotonus." The formula for the sounds obtained is as follows:

C. C. S. = cathodal closing sound, a distinct accentuated sound.
C. D. > = cathodal duration, the sound continuing to disappear gradually and by degrees.
C. O. = cathodal opening, no sound.
A. C. = anodal closing, no sound.
A. D. = anodal duration, no sound.
A. O. S. = anodal opening sound, feeble sound.

It is unfortunate that results so definite as these do not offer to us clear indications as regards thc treatment of nerve-affections. It must be admitted that they are not infallible guides.

SIMPLE GALVANIC HYPERESTHESIA

101. Simple galvanic hyperesthesia is a term applied to a moderate hyperesthesia of the auditory nerve that leads to an increase of the normal formula. A high grade of hyperesthesia gives what is known as the *paradox* formula and is characterized by a curious phenomenon. If we apply the examining electrode to one ear only, the unexamined ear reacts as if it were influenced by the indifferent electrode. The indifferent electrode may be in the patient's hand or on the sternum, and the effects will be the same. It is an expression of a very high degree of galvanic irritability and has no further significance. It affords a hint to us in thc treatment that we should arm both ears with one divided electrode. Any alteration of the formula necessarily indicates a disease of the nerve itself, and in all such cases the constant current may be afforded a trial. There is little to be said in favor of it. The conditions wherein it is serviceable will be distinctly pointed out.

TINNITUS AURIUM

102. Tinnitus aurium may be due to a variety of causes, and in each case the etiological factors should be attacked if one desires to cure the affection. By this alone will any definite results be attained. Some cases are incurable, but many of the most persistent and intractable may be ameliorated by patient effort.

In the first place, the physician should ascertain by means of the formula whether or not the sounds are due to disease or irritation of the auditory nerve. If the sounds are normal, it may be assumed, though not conclusively, that the nerve is normal. If the sounds heard by the patient during the examination are *with* the formula, good results may be obtained. The active electrode is generally an ordinary aural sound well wrapped with moist cotton, and so placed upon the tragus as not to occlude the external meatus. The duration of the sitting must be governed largely by the subjective sense of the patient. Frequently, the noises cease directly on starting the current, in which case the applications need not consume much time; but in some instances they cease only after a considerable continuance of the current. The time necessary for a single sitting may vary, therefore, between 5 and 25 minutes, approximately. The rheostat should be made gradually to withdraw the current until the milliammeter rests at zero before the electrodes are withdrawn.

103. Tinnitus, which is associated with hyperesthesia and with experimental sounds *against* the formula, is oftenest relieved by *C. C.* and *C. D.*

Tinnitus, associated with nervous deafness and deafness without any discoverable lesion, but with altered formula, may be greatly improved or even cured by this plan of treatment. Generally speaking, it may be said that where, in such cases, the formula is normal the anode is the active electrode, and where the reaction is anomalous the cathode should be used. The galvanic reaction must always be tested. It has been recommended to fill the ear with saline-solution and to immerse the electrode in the fluid, but the procedure is apt to modify

the sounds or to give rise to adventitious noises that confuse both patient and operator. The position of the indifferent electrode is of minor importance, so long as it is remote from the unengaged ear. Should the tinnitus be found associated with a paradox formula, we must make use of a binaural electrode. It has been suggested that an ordinary stethoscope be used for this purpose.

104. The patient is advised always to pay close attention to the sounds he hears during the treatment. He is the sole index of the correctness of the work. Some idea as regards the prognosis in a given case may be gained by the results of the first sitting. We shall suppose a man to have tinnitus with normal formula. If the sounds cease or diminish on the application of the anode, the operator may feel encouraged. The outlook is bad if the sounds are unchanged in character or intensity. Treatment may be given daily for a week and three times a week for 2 or 3 weeks following.

Tinnitus, which is due to middle-ear disease, is generally relieved by Eustachian catheterization and routine methods. The stubborn cases associated with ankylosis of the ossicles are sometimes favorably influenced by faradism.

105. Some of the French specialists have used cupric diffusion or cataphoresis in the treatment of ringing in the ears due to an abnormally dry condition of the nasopharynx. A copper bulb is the active electrode and is connected to the anode terminal. The bulb is introduced, usually through the nasal passage, into the nasopharynx. From 8 to 12 milliamperes of current are allowed to pass for 5 minutes.

The static *souffle*, applied either directly to the ear or indirectly to the pharynx through the open mouth, has given relief in some cases which were not benefited by other forms of treatment.

Electrotherapeutics has failed to establish itself as an available agent in the treatment of *deafness*. Faradic currents of moderate intensity are valuable in deafness of the neurotic type, but in that due to labyrinthine disorders and to middle-ear diseases there is little to be gained by electricity in any form.

OTALGIA

106. Neuralgic troubles about the ear may be quieted temporarily by the use of the constant currents, with cocain-solution. The details of this method of treatment have been mentioned previously.

DISEASES OF NOSE AND THROAT

107. It will be convenient for us to consider the diseases affecting the upper respiratory passages together, for the reason that these conditions are frequently interassociated and require treatment at the same time. We shall observe the application of principles already well known to us. Galvanism, faradism, electrolysis, and the electrocautery and snare find extensive utility, both as aids to routine procedure and as curative measures themselves. Within late years much has been done toward obtaining adequate means of illumination of the cavities. Electric lamps of small caliber mounted upon tongue-depressors and holders of various patterns have reached a high grade of perfection and permit the direct illumination of any area that the specialist desires to inspect, whether it be in the nose, pharynx, or larynx. Illumination is an indispensable item in the armamentarium of the practitioner, but it matters little whence its source so long as it possesses the chief requirements. The source of light is largely a matter of individual preference or custom. The operator must avail himself of apparatus that will aid best in furthering good technique. Some of us grasp eagerly at the latest improvements while others cling to those appliances to which we are accustomed and which have stood us in good stead.

A short discussion as to the limitations and scope of electro-therapeutics in the hands of the rhinologist and laryngologist will not be out of place. He who excludes entirely all electrical agents from his therapeutic resources will fail as signally in his work as the one who attempts to make of them a cure-all. Each curative or palliative measure has its own field of application. None will accomplish anything singly but each will serve according to the indications. The specialist should be as

familiar with one resource as another and should use the electrolytic needle or the cautery-snare with the same confidence that renders easy the administration of an alkaline spray. Our subject naturally precludes the possibility of a wide range of therapeutic references or anything like a systematic review of treatment, and the student will understand that in our effort to state the essentials of electrical applications we are emphasizing a resource too often neglected and omitting the various steps of routine management merely through lack of space.

RHINITIS

ACUTE RHINITIS

108. Nature.—The pathological conditions that accompany the common affection known as *acute rhinitis* are so thoroughly understood as to call for no comment. The symptoms are characteristic and the prognosis favorable so far as the attack itself is concerned, but unfavorable as regards recurrences and the chronic state, which is such a frequent sequel. The treatment should include both general and local measures, the former directed toward a stimulation of the circulation and calming of the nervous apparatus by diaphoretics and sedatives, such as ammonium chlorid and opium, the latter aimed against the tumefaction of the nasal mucosa and the stimulation of the sluggish blood-stream in the vascular sinuses. For this purpose powders of morphin and bismuth with alum may be insufflated or cocain in a 4-per-cent. solution may be applied directly to the inflamed surfaces. The use of the latter remedy should never be entrusted to the patient. Some persons acquire what may be termed the *habit* of catching cold. This is due largely to lack of attention to hygienic surroundings as well as repeated attacks of coryza. It cannot be correctly termed a chronic condition since the patient is more or less free from annoyance during the interval between attacks. The nasal mucous membrane, particularly that covering the lower turbinate body, becomes relaxed and somewhat intumescent. The continued hyperesthesia that accompanies such a

state leads to attacks of coryza at the slightest stimulation, be it a draft of air or a dust-laden atmosphere.

109. Treatment.—For the relief of this condition no treatment is better than the exhibition of the electro-cautery. Select a cautery-tip of platinum of small size, such as is shown in Fig. 44; attach it to the cautery-handle and control the current in such a manner as to bring the tip speedily to a *cherry* or glowing heat. Cleanse the nasal cavity of one side thoroughly with a mild solution of borax, or other alkali, and apply to the region of the inferior turbinate, through the speculum, a 4-per-cent. solution of cocain. Now select an area upon the turbinate where the tissues are the most redundant and hyperesthetic and bring the cold cautery-tip in relation to it. Remove the tip but a fraction of an inch from the tissues and close the electrocautery circuit. The flat side of the tip at a cherry heat is brought in contact with the tissues over the desired area. Scarcely more than a touch is required. The circuit is to be broken as soon as the cautery has fulfilled its mission and the instrument withdrawn cold.

FIG. 44

This treatment should be supplemented by daily douching with a solution of bicarbonate of soda followed by a spray of camphorated oil. But one nasal cavity is to be treated at a time, and an interval of a week should elapse before the other cavity is similarly dealt with. Fig. 45 shows the relations of the structures in the left nasal cavity. The most frequent site for cauterization is marked by x. This method of treatment is not recommended for simple or first attacks of acute rhinitis unless accompanied by considerable intumescence, which does not readily yield to ordinary measures. It applies particularly well to that state which occupies the border-line between the acute and chronic conditions.

A word should be said in regard to the different degrees of heat to which the cautery may be raised. A white heat is painless since the nerve-filaments, which conduct afferent impulses,

are immediately destroyed by it. In tissues that are very vascular the use of a tip heated white is not without risk, owing to the tendency to hemorrhage that follows. A dull heat, or one that does not glow, is very painful indeed, and does not produce the necessary destruction of tissue. A tip so heated shows a tendency to adhere to the tissues, also. When

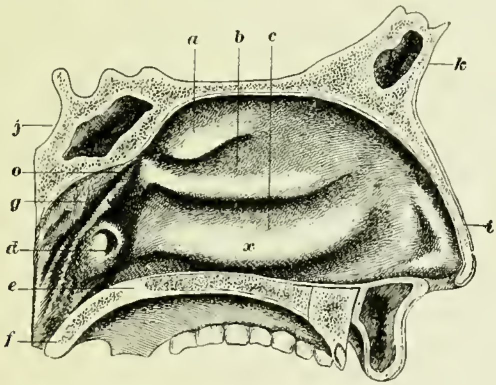

FIG. 45

a, Superior Turbinate Body. b, Middle Turbinate Body. c, Inferior Turbinate Body. d, Eustachian Orifice. e, Posterior Limit of Hard Palate. f, Uvula. g, Nasopharyngeal Crypts. j, Sphenoidal Sinus. k, Frontal Sinus. o, Spheno-palatine Canal. i, Nasal Cartilage.

we use a cherry heat we accomplish what is desired in the superficial destruction of tissue and the stimulation of the vasomotors. The pain is not great and the tendency toward hemorrhage is obviated. The different gradations of heat are easily acquired by practice, and one learns almost automatically to *set* the controller so as to obtain the particular degree of heat that is desired.

SIMPLE CHRONIC RHINITIS

110. Nature.—The effects of long-continued or frequent attacks of inflammation in the nasal chambers lead eventually to distinct and permanent alterations in the tissues. The blood-vessels become greatly distended and the power of contractility of their walls is diminished. The walls become thinned out and are quite permeable to the blood-elements. By reason of

the continued irritation and inflammation, the areolar and submucous tissue becomes engorged with leucocytes and pus-cells, which, together with serum and glandular products, give rise to the discharge from the nose. The preponderance of any one of the concomitants of the exudation will determine the character of the secretion, whether it is serous, mucopurulent, or decidedly purulent. The blood-sinuses of the turbinate bodies partake of the morbid changes to some extent. The symptoms do not require mention. To the specialist who takes pains to examine every case which presents itself, as a routine measure, the picture of the nasal chambers is quite characteristic. While the tissues respond, after a manner, to the nature of the exciting cause, a fairly uniform condition is found. Examination of the anterior and posterior nares shows a mucous membrane covered with secretions more or less ropy and purulent. Upon wiping or cleaning the parts with the douche the mucosa appears dark red and swollen, and the tissues pit on pressure and perhaps bleed easily to the touch.

Confronted by such a picture, which represents a definite pathological condition, the physician must realize that successful treatment will depend on certain factors. In the first place, measures directed toward relief must take cognizance of the exciting cause and remove it if possible. Then it must be borne in mind that the routine agents, such as cleansing and antiseptic and astringent powders, bougies, and solutions, while admirable as palliatives, do not contribute toward permanent alleviation. Their use must be persisted in for long periods of time, and at their discontinuance the tissues are prone to relapse into their chronic state. Radical measures are necessary. The parts must be so handled that organized tissue may bind down or shrink the distended structures, and the agent that will best contribute to this end is an escharotic. Better than nitric acid or other remedies is the electrocautery, which, applied to the tissues, will produce scar-tissue that by its contraction will permanently modify the conditions present.

111. Treatment.—The cautery-tip shown in Fig. 44 will answer or one similar to those shown in Fig. 33 will suffice. The

cautery-apparatus must be in good order and the current so modified as to yield a cherry heat upon closure of the circuit. The nasal chamber to be operated on is to be thoroughly cleansed with a mild alkaline spray and cocainized with a 4- to 6-per-cent. solution. The operator dilates the anterior nares, and with the cold tip of the cautery marks out the spots upon the mucosa which he is to attack. Fig. 46 shows a section of a chamber that is affected with chronic rhinitis. The X-marks roughly designate the areas to be touched. The heated tip is now brought into service, and its edge is introduced into the most prominent parts of the tissues, deep enough to penetrate to the submucous structures. The punctures should be as few and as far apart as possible. Following the cauterizations, the chamber should receive daily treatment with cleansing solutions and oily sprays.

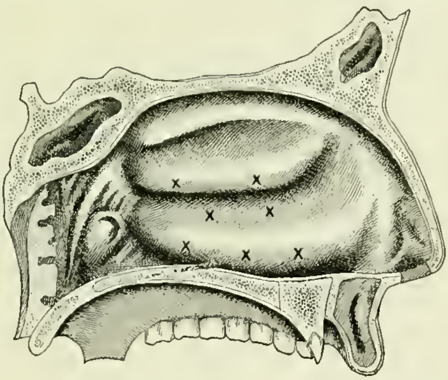

FIG. 46
Chronic Rhinitis

112. It will be necessary to speak of the complications that occasionally arise following the use of the electrocautery. The instrument is in itself sterile but the difficulty of maintaining thorough asepsis of the nasal cavities is considerable. Inflammation of the middle ear, thrombosis of the accessory sinuses, erysipelas, mastoid disease, and septic meningitis have followed cauterization, and the operator should bear these facts in mind. In addition, there is frequently a tendency for adhesions to form between the burned spots and the septum, particularly when these areas are in close proximity. To guard against this undesired sequel, the parts should be inspected frequently and any bridges broken down. If the tendency to

unite is apparent, the two portions may be kept apart by small cotton-tampons moistened with camphorated oil or sterile vaseline. Neglect of these precautions will contribute toward firm synechia between the septum and turbinates and annul the good which one seeks to accomplish. In all operative measures upon the turbinates that necessitate the use of escharotics the practitioner must scrupulously avoid injury to the septum.

HYPERTROPHIC RHINITIS

113. Nature.—The two preceding affections lay the foundation for the hypertrophic variety of rhinitis, although in rare instances no apparent cause is at hand. Such instances of idiopathic hypertrophy are very rare. There are many symptoms and appearances common to this condition and to simple chronic inflammation, and it is essential that a complete differentiation between the two disorders be made. To accomplish this, routine examinations of each case should be made. It has previously been observed that chronic inflammatory troubles of the nasal mucosa were accompanied by a considerable thickening or tumefaction. In the present instance this thickening has reached a stage wherein not only the mucous membrane but the submucous tissue and the "corpora cavernosa" are involved as well. The increase consists largely in connective tissue and the elements that go to form it, which becomes vascularized and organized, and all the normal structures are proportionately increased. In the examination of such a case it will be observed that the increase is scarcely uniform. Some parts are more thickened than others and this gives an uneven appearance to the structures. The turbinate bodies seem greatly enlarged. The lower turbinate may fill the entire lower meatus and the middle one may project horizontally so far as to touch upon and ulcerate the septum. In simple chronic rhinitis we said that the tissues pitted on pressure, but in the hypertrophic variety there is no pitting. So elastic are the structures that they spring back into position as soon as pressure is removed. Hypertrophies that occur anteriorly have an appearance different from those situated near the posterior nares. The former may be dark red or nearly normal in color, while the latter

are usually purplish or quite light in color. The posterior thickenings assume a mulberry outline as a rule, while no particular shape characterizes the anterior enlargements. The proliferation of tissue is not always limited to the turbinates. The septum may share the process (see Fig. 47). The secretions are considerable. The contractile power of the tissues

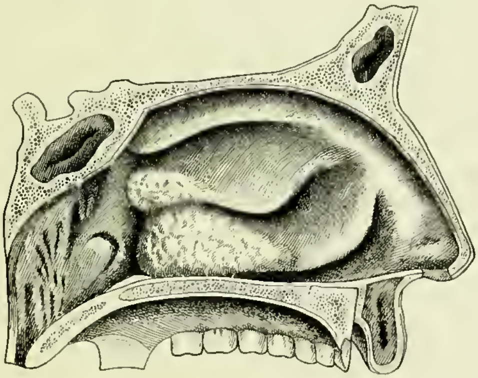

Fig. 47
Hypertrophic Rhinitis

as compared with that in chronic rhinitis is almost wanting. The application of a solution of cocain may clear up the nature of a case that has rested in doubt. Where the organization of the fibrous tissue is lacking the parts will shrink to their natural size or nearly so.

114. Treatment.—From what we have said in regard to the pathology of hypertrophic conditions it is obvious that palliative treatment is of no avail and that radical measures only will efficiently serve. The object aimed at in the treatment is to produce an eschar of such shape, magnitude, and depth as to cause, by the subsequent contraction of the resulting scar-tissue, a shrinkage in the parts. Since the character and size of the hypertrophies vary with the location in the nasal chamber it follows that therapeutic measures must undergo modifications. The anterior hypertrophies generally require the escharotic and no more, but the posterior enlargements most frequently demand the entire removal of a portion

of the redundant tissue. Each hypertrophic mass is a diseased focus in itself and the operator must needs regulate his treatment to its demand. The larger and more dense the mass the more extensive must be the eschar. Some of the smaller enlargements may safely be overlooked entirely, trusting to the neighboring reparative process to exert an influence which, while it does not produce a diminution, will favor a retardation of further organization. The radical agents at our disposal are the various escharotic acids—nitric, chromic and acetic—the cold snare, and the electrocautery and snare. The best results are to be gained by the use of the electrocautery and the electrocautery-snare. There are cases, however, where even these drastic measures are inadequate. Some hypertrophies take on the character of new growth, are dense and inelastic, and do not readily yield to electrocautery puncture. In such intumescent growths the best results follow electrolysis.

115. We shall first deal with the ordinary hypertrophies that are located anteriorly. The nasal chambers should be thoroughly cleansed with an alkaline spray and the site to be operated on should be wiped dry. Under direct illumination the diseased area is then rendered bloodless by the employment of a 1 to 1,000 solution of adrenalin hydrochlorid and anesthetized by a 6-per-cent. solution of cocain. A cautery-loop or cautery-tip (Fig. 48) of platinum must be attached to a convenient handle and placed in the circuit.

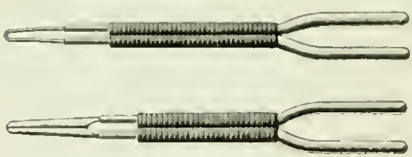

FIG. 48

Regulate the current carefully until the tip is brought as speedily as possible to a cherry heat. Then, under thorough illumination, the nostril is dilated and protected by a metal or hard-rubber speculum. The septum and the tissues near the site of operation are to be touched with vaseline to protect them from heat. The cold cautery-tip is now introduced and the hypertrophic patch touched once or twice for practice. This is a good procedure in another way, as it reassures the patient to some extent. The

tip is now withdrawn until it lies within the speculum, when the circuit is closed, and as soon as the heat has reached the desired grade the instrument is carried quickly to the proper site and the edge is made to puncture the tissues well down through the mucous and submucous structures. If the area to be cauterized is elongated, the puncture should assume more the character of an incision. Just as soon as the cauterization is complete the circuit should be broken and the tip withdrawn cold. The reaction is usually very mild. Occasionally, an inflammation of some magnitude is set up, but such a complication is rare and usually subsides without giving rise to serious trouble. The patient should be seen daily for a week following the operation. Alkaline douches, oily sprays, and the prevention of synechia constitute the ordinary after-treatment. A week should always elapse before operative steps are resumed.

116. Removal of Tumors.—It frequently happens that intumescent masses occur coincident with the ordinary broad or narrow hypertrophies. These may also be present to the exclusion of other varieties of enlargement, but in either case their treatment is the same. Electrolysis offers the best means for their removal. As we recall the pathological conditions present, the engorged and dilated vessels and sinuses, and the newly organized growth with its own vascular supply, it will be apparent that the electrolytic needle must bring about a coagulation of the vessels and cut off the blood-supply of the parts in order to produce lasting effects. We therefore select the anode as the active electrode. An iridoplatinum needle suitably mounted in a convenient holder should be employed. For tumors of ordinary size the monopolar method is most serviceable, whereas if the masses are very large, the bipolar treatment should be used. The method of application is

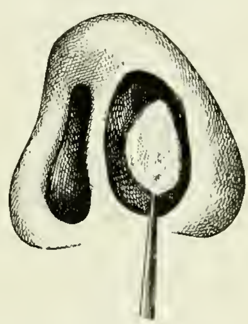

FIG. 49

Showing Intumescence and Electrolytic Needle in Position

similar to that described earlier. The cathode or indifferent electrode may be applied to the back of the neck or to the shoulder of the patient. With the parts under thorough illumination and well anesthetized with a 6-per-cent. solution of cocain, the anode needle is introduced through the intumescence near its base (see Fig. 49). A current of 1 to 3 milliamperes is allowed to pass for from 2 to 8 minutes. Should the needle be firmly grasped by the tissues following the passage of the current, the polarity should be changed for a moment before attempting its withdrawal. An interval of 3 or 4 days should elapse before treatment is resumed. Two or three sittings are usually sufficient, the puncture being made in a different location each time. The reaction is slight. Cleansing solutions of a mild alkaline nature should be used daily, followed by soothing, oily applications.

117. The bipolar method has no essentials different from the preceding. The method of introduction of the needles is

FIG. 50

Electrocautery-Snare and Handle

the same. The needles themselves should be mounted not more than $\frac{1}{8}$ inch apart in a convenient carrier. The strength of current requisite may reach 5 milliamperes, and the duration of the sitting should be about the same as in the monopolar method. The treatment should be continued until the diminution in size of the masses warrants its discontinuance.

118. Use of Snares.—When the hypertrophic masses are of large size or situated near the posterior nares, a different plan of handling them must be inaugurated. Here the cold snare of the electrocautery-snare or Vulpius's curette may be used to advantage. The electrocautery-snare in experienced hands will attain the best ends. The operator must determine what form of snare is best adapted to the work and the variety that he can most skilfully manipulate. Fig. 50 shows a

convenient snare and handle. Another variety of handle is seen in Fig. 51. Some operators employ a universal handle suitable for use with both cautery and snare (see Fig. 52). It is essential that the practitioner should acquire a practical knowledge

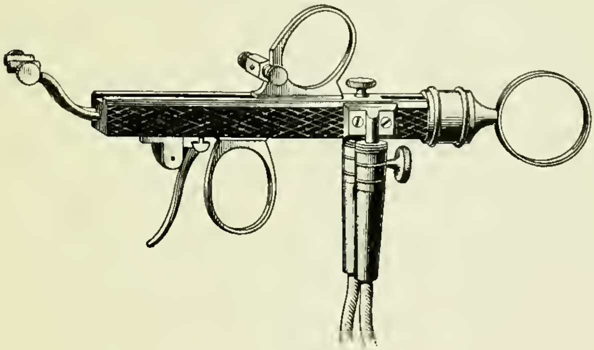

Fig. 51

of the amount of current necessary to heat a loop of platinum wire such as is used in the snare. The amount of resistance to be overcome requires more E. M. F. than we have been accustomed to use heretofore. Too strong a current will fuse the wire. The operator should throw into the circuit sufficient

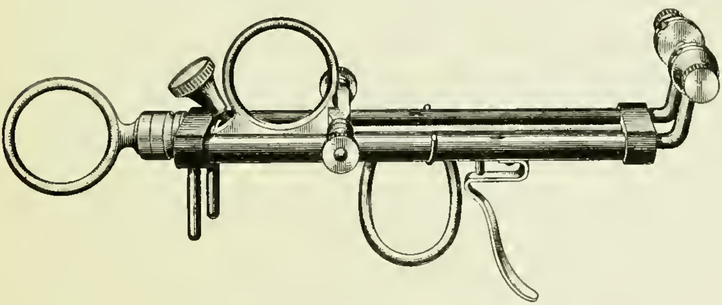

Fig. 52
Universal Handle

resistance at first so that the loop does not glow at all, and then gradually diminish the resistance to a point where the wire glows at the intensity desired. Very large hypertrophic masses situated anteriorly are well adapted for snaring, but some means

of steadying the growth and preventing the snare from slipping is requisite. Jarvis needles serve the purpose admirably.

119. To apply the snare, dilate the anterior naris under good light and apply solutions of cocain and adrenalin hydrochlorid. Transfix the hypertrophy about midway between base and summit with a Jarvis needle. Thread the loop of the snare over the handle and blade of the needle and draw it snugly to the mass to be removed. As soon as all is in place close the circuit and tighten the loop by means of the nut, screw, or trigger in the handle (see Fig. 53). A portion of the redundant tissue is thus removed. There is no hemorrhage and the wound closes, as a rule, in a few days. Routine measures of antisepsis should never be neglected following an operation of any character.

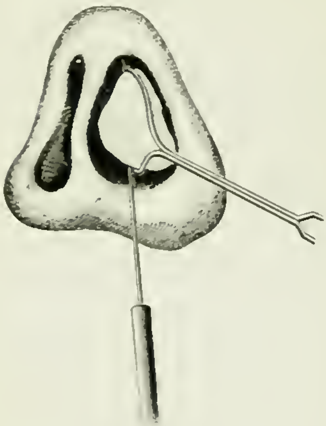

Fig. 53

120. Rhinoscopic Mirror.—In the diagnosis and treatment of postnasal hypertrophies the rhinoscopic mirror is indispensable. It is essential to obtain a clear image of the posterior nares, and in persons with sensitive throats, this is not always easy. A cocain spray (10 per cent.) will facilitate matters materially. Having made a complete diagnosis of the conditions present, it devolves upon the specialist to remove the mulberry, or polypoid masses that block the posterior nasal chambers. By means of a flexible bougie or a Bellocq cannula, introduce a long, narrow piece of sterile tape or gauze through the mouth and out along the nasal floor and tie the extremities at the upper lip. This holds the soft palate and uvula well forward and out of the way. Under steady illumination, place the rhinoscopic mirror in position and hold it there while the cold electrocautery-snare is introduced into the nasal passage of

one side—the side to be operated on. By means of the image in the mirror (see Fig. 54) the operator is able to see that the loop is perfectly adjusted to the mass, and is in a position to sever the tissues in a direction from behind forward [see Fig. 54 (*a*)]. The circuit is now to be closed and the loop drawn home. The circuit is then opened and the instruments are removed. The operation is almost painless. For a week following, the parts should be douched daily with mild antiseptic and alkaline solutions, using an ordinary postnasal douche for the purpose.

FIG. 54

Rhinoscopic Image of Snare in Position

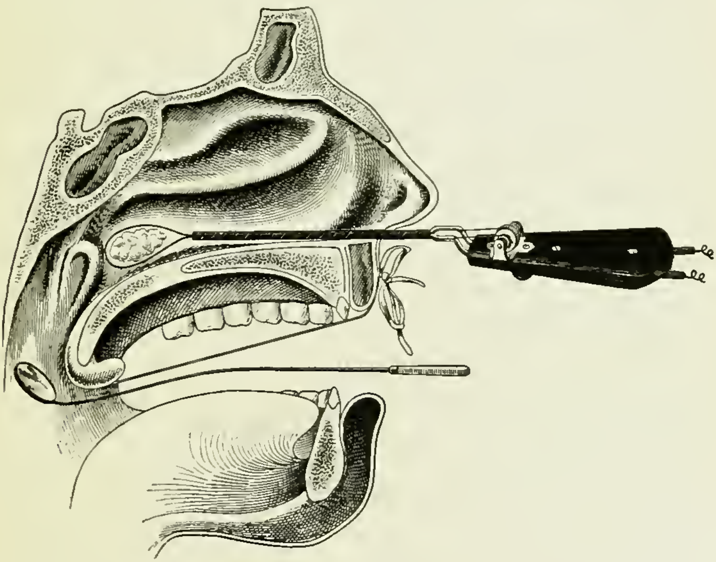

FIG. 54 (*a*)

Showing Method of Removing Posterior Hypertrophies by Means of the Electrocautery-Snare

121. The only contraindications to the employment of electrolysis or the electrocautery are such constitutional states

as usually militate against operative procedure. Anemic and hemophilic patients should be given the benefit of palliative treatment only, and the subjects of pulmonary or general tuberculosis may be exempt from all but the gentlest measures and those absolutely necessary.

ATROPHIC RHINITIS

122. Forms of Atrophic Rhinitis.—There has been considerable confusion in regard to the interpretation of terms defining this condition and closely allied states. Atrophic rhinitis has been made to cover ozena, simple atrophy, and the strumous type of the older writers. We shall throw aside the last term altogether and discuss only two forms of atrophic rhinitis, the *simple* and the *fetid*, or ozena. In order that one may correctly appreciate the character of treatment which these conditions call for, a glimpse at the pathology and morbid anatomy of these two states will be necessary.

123. Simple atrophic rhinitis presents a picture altogether opposed to that observed in the hypertrophic forms of inflammation. The affected structures, instead of taking on an increase of tissue-elements, exhibit rather a state of more or less permanent infiltration that shows no attempt at organization or absorption. The blood-vessels do not grow into the infiltrated layers, but the diapedesis from the normal vessels is extreme and the leucocytes pack the submucous and subepithelial spaces, coming to the surface in a state of partial necrosis. The cavities of the nose are not choked but tend rather to a roomy condition, which admits of abundance of air and favors the desiccation of the secretions. The glandular elements in the nasal mucosa are compressed and rendered functionless by the morbid process. The combination of these factors, that is, the desiccatory effect of free currents of air in respiration and the failure of the glands to lubricate the chambers of the nose, produces a dryness of the entire mucosa and the formation of crusts or scabs. These scabs are found usually in the deeper fossæ and recesses, and produce, by their irritating action, ulceration of the tissues beneath them. If

dislodged or separated, bleeding frequently results. The breath is tainted with odor to an appreciable extent. The constitutional state of the individual is usually impaired.

124. Methods of Procedure.—From the superficial glance we have taken of the conditions that confront us, it becomes apparent that all treatment must be aimed toward the removal of the crusts, the healing of the ulcers, the lubrication of the membranes, and the stimulation of the tissues toward a state of healthy activity. The outlook is not always encouraging. The first indication, the removal of the crusts, is best met by douching the parts with borax-solution, dilute hydrogen peroxid, or normal salt-solution. The more tenacious scabs may be brushed off by means of the cotton-wrapped probe. The ulcers are best dealt with by touching them with the flat blade of the electrocautery-knife in the manner hitherto described. The blade should be introduced cold and brought to a white heat at once and the floor of the ulcer lightly touched. The knife should be withdrawn cold. It is needless to add that the procedure should be effected under thorough illumination, either directly on ulcers situated anteriorly or indirectly by means of the rhinoscopic mirror if the ulcers occupy the posterior fossæ. Not more than two or, at most, three ulcers should be treated at a sitting, and an interval of 4 to 7 days should elapse before treatment is resumed. Alkaline and antiseptic douches should follow. The two indications last mentioned, namely, the lubrication of the mucosa and the stimulation of the tissues are best fulfilled by the judicious use of the mild constant current.

125. Treatment.—The application is as follows: Select a metal nasal electrode that is shaped something like a female catheter and attach it to the cathode terminal of the battery or source of current. Instead of a nasal electrode the operator may avail himself of an ordinary piece of copper wire well wrapped with absorbent cotton. This has the advantage in that it may be bent into any desired shape and serves the purpose equally as well, if not better, than the metallic conductors. The active electrode is made the cathode and is

introduced into the middle or lower fossa of one side of the nose, while the anode, or indifferent electrode, in the form of a moistened plate, is applied to the cheek or shoulder. Commencing with no appreciable current the strength in milliamperes may be raised to 3 and continued for 10 minutes or until a rather copious watery discharge from the chamber is induced. The other chamber may be subjected to a similar manipulation at the same sitting or on the following day. Vibratory massage is a good adjuvant to the treatment. Sittings may be held as often as three times a week for a considerable period. There is little or no reaction beyond a marked stimulation to secretion and a quickening of the arteriovenous circulation of the parts.

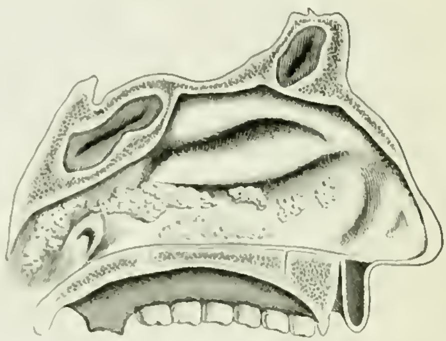

FIG. 55
Atrophic Rhinitis

Inflammatory reaction is not observed. Patient perseverance along the lines above indicated, coupled with attention to the patient's general health and surroundings, will undoubtedly bring about a decided amelioration of the condition if not an actual cure. The operator is cautioned against the use of powerful stimulants of all kinds. The use of silver nitrate is contraindicated. The cautery should never be brought in contact with tissue not bearing an ulcer. Its use is seldom indicated and then only where there is actual loss of substance. Fig. 55 shows the usual sites of the scabs and the corresponding ulcers beneath. Faradism has been tried in atrophic rhinitis and has met with slight favor. Galvanism serves to a better purpose.

It is not to be forgotten that the nasal passages are very sensitive to stimuli of any character, and the patient may complain of certain reflex phenomena during the passage of the electric current. Sneezing is very common. Coughing may be very persistent and there is usually some lacrimation. Local pain and ringing in the ears and pain along various divisions of the fifth nerve are frequently observed.

FETID ATROPHIC RHINITIS, OR OZENA

126. Nature.—We are inclined to look on this condition as the expression of a trophoneurosis, a state characterized by anomalous nasal secretions. The precise etiological factor is not apparent, though we turn involuntarily toward constitutional states in seeking a cause, and certain it is that this affection most frequently occurs in young and debilitated subjects. Whatever may be the exciting cause its results supply the culture media upon which thrive the micro-organisms that give rise to the nauseating odor so characteristic of the affection. The malnutrition of the nasal mucosa, which is an invariable concomitant of the morbid process, ultimately leads to atrophy, especially of the turbinated bodies. The secretions, which are at first rather copious, somewhat ropy, and stinking, become scant and more viscid owing to the desiccating effects of the easily respired air and the alteration of the glandular structures. Crusts form, which ultimately lead to ulceration and hemorrhage. The patient seeks relief from the foul and intolerable odor which makes life a burden and necessitates almost complete seclusion.

127. Treatment.—Palliative measures, which consist in cleansing solutions, massage, and galvanism, may all be tried, but the condition demands more active therapeutic measures. While it is occasionally true that a young person will outgrow the affection, it more frequently happens that the affected individual bears throughout the greater part of his days the taint of the trouble, or else the hypertrophic form of inflammation brought on by recurring attacks due to the products of

ozena act as foreign bodies in the nasal cavities. The electrocautery has its place in the treatment of ulcers that appear upon the removal of the crusts. The method of application has already been referred to. The treatment, however, which has yielded the best result and is the plan of procedure par excellence is cupric cataphoresis, cupric electrolysis, or anodal cupric diffusion. It is well known that the anode is the disseminator of salts which are in relation with the electrode. Depending on this principle a copper electrode is made the anode, and a deposit of oxychlorid of copper is formed in the tissues. This deposit in some manner leads toward a stimulation of the structures, and aids in a restoration of a healthy state.

128. The method of application of cupric electrolysis may now be explained. Select two long, slender needles, one of

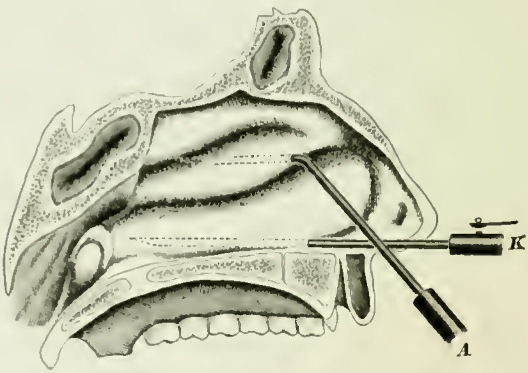

Fig 56

pure copper and the other of iridoplatinum. Each is mounted in a needle-holder. The former is made the anode and the latter the cathode. Introduce resistance sufficient to bring the milliammeter to zero. The nasal passages are thoroughly cleansed with a mild, warm solution of borax (ʒ$\frac{1}{2}$ to O$\frac{1}{2}$) and all adhering crusts are wiped away. Any bleeding surfaces are to be touched with a $\frac{1}{1000}$ solution of adrenalin hydrochlorid. If the patient is a child, a general anesthetic is required, but for adults the application of a 6- to 10-per-cent. solution of

cocain will render the operation painless. With the parts thoroughly illuminated the copper needle or anode is introduced into the tissues over the middle turbinate and passed along its entire length. It matters not if bone is encountered. The platinum needle *K* is similarly introduced into the tissues of the septum on the same side or along the nasal floor, as shown in Fig. 56. The current is now gradually increased until 10 to 15 milliamperes is passing. In spite of the fact that many operators use as high as 25 milliamperes, 15 milliamperes should not be exceeded. The duration of the sitting should not exceed 15 minutes. During the passage of the current the patient may complain of pains in the head and teeth, and at the same time, coughing, sneezing, lacrimation, and noises in the ears. These cease on opening the circuit. At the conclusion of the sitting it will occasionally be found that the copper needle is firmly adherent to the tissues. Reversal of the polarity for a moment will insure its easy withdrawal. Some patients will exhibit no reaction whatever following the electrolysis, while, again, others will now and then show a decided inflammation of an acute nature, which may not only affect the nasal passage of both sides, but extend to the neighboring sinuses. The trouble usually yields without further complications.

The results of electrolytic treatment are manifest in certain changes, which consist of a modification in secretion, the softening of crusts, and a marked diminution of the offensive odor. The secretions, which were thick, rather scanty, and odoriferous, become liquefied, the crusts become swollen and easily dislodged, and the breath of the patient becomes much less tainted. The electrolytic action is not wholly confined to one side of the nose, but is felt in the neighboring chamber as well. Almost every patient is decidedly benefited by one sitting. More than two electrolytic applications are seldom necessary. The after-treatment should consist in mild, warm, cleansing, and antiseptic douches, which the patient may be taught to administer to himself three times daily. It is fortunate that we have at our command a therapeutic agent that will yield such favorable results. The patient is willing and anxious to try any measure that will alleviate his pitiable state and make of a taciturn

recluse a useful member of society. It is scarcely necessary to state that only fresh, new needles should be used at each sitting.

TUBERCULAR RHINITIS

129. Nature.—Tubercular ulcerations in the nasal cavities demand early and thorough treatment. So long as any focus of disease lingers, even though the process be very benign in character, as is frequently the case where the disorder affects the mucous membranes, just so long will the patient run the risk of acquiring a general or a pulmonary complication. Radical removal of the diseased area is called for. It is important, however, not to confuse this condition with the syphilitic variety of ulceration, but the history of the case and the character and location of the ulcers will usually clear up any uncertainty.

130. Treatment.—General and tonic treatment is of prime importance. Good, fresh air and an out-of-door life should be insisted on. Cleanly habits in regard to the care of the nasal cavities are indispensable and the patient should familiarize himself with the use of the douches. The electrocautery affords the best results in the removal of the ulcerated areas. After a thorough cleansing of the chamber, a 10- to 20-per-cent. solution of cocain should be applied, followed by an application of adrenalin hydrochlorid $\frac{1}{1000}$. With the parts well illuminated through a speculum, the cautery-blade or cautery-loop of platinum is introduced cold and brought to a white heat as soon as it is brought near the ulcer. The tissues constituting the floor of the ulcer are to be thoroughly seared well down into the submucous structures. Allow the tip to cool and inspect the parts. It is well to bring the tip to a cherry heat and to touch again the cauterized area to assure the prevention of hemorrhage. Two or more small ulcers may be dealt with at a sitting, or one large one. Other foci may be handled at a subsequent time. An interval of a week should be allowed to pass before the second cauterization.

Following the operation there will be a rather sharp intumescence and inflammatory reaction, which, however, usually

subsides without causing trouble. Alkaline and antiseptic douches of mild strength are indicated daily. An oily spray tends to keep the irritated surfaces moist and protected.

HYPERESTHETIC RHINITIS

131. Nature.—It is beyond the province of a work of this kind to enter into anything like a complete discussion of the etiology and pathology of *hyperesthetic rhinitis*, or *hay-fever*, as it is most frequently called. The student will gain much from a perusal of the various articles in the text-books devoted to the subject. The history of the affection and the numerous experiments that have been made in the effort to substantiate various theories in regard to the causation should be familiar to every one. Probably no condition has given rise to greater speculation and interest, partly on account of its obscure nature and partly because of its widespread existence. The suffering of a patient with hay-fever will induce him to accept almost any effort in his behalf, and the fact that some have been benefited by a change of scene has contributed largely to the climatic treatment of the disease. It is well established that no one climate or altitude is adapted to all cases. A native of a reputed resort may even exchange locations with another sufferer. In all probability the radical change of surroundings which any travel affords is the active therapeutic agent. The reason for this is apparent when we consider the neurotic factor that doubtless enters into all cases. We cannot deny at the same time the potency of factors other than the neurotic, such as the peculiar idiosyncracies of individuals to different irritants and the local conditions of the nasal mucous membrane, which occasionally combine to defeat any plan of treatment other than a radical or operative one. Each factor deserves particular consideration at the hands of the specialist, but perhaps the most important one is the local condition of the nasal chambers. Many attacks of coryza, which simulate closely the onset of hay-fever, may be due to nasal spurs, rhinoliths, or some irregularity of such nature. Again, an area of hypertrophy may be a source of irritation that will render the individual responsive to

the slightest stimulus, such as a draft of air. Such facts should lead us always to a careful inspection of the respiratory passages. By this means alone are we able to differentiate accurately these similar conditions.

True hyperesthetic rhinitis may, and frequently does, exist without apparent lesion, but in such cases certain definite areas of hypersensitiveness to touch are always in evidence. These areas usually correspond to the tissues governed by the filaments of the ganglion of Meckel and the nasal branches of the ophthalmic nerves, and are situated on the middle and posterior portions of the middle and inferior turbinates, and in the anterior portion or vestibule of the nasal cavity. The touch of a probe is sufficient to arouse these sensitive spots, and intense itching, lacrimation, and sneezing, accompanied by congestion and increased secretion, are the results. Hysterical sneezing is a condition altogether different and may be relieved by this very procedure. The two states may, however, resemble each other strongly.

132. Treatment.—In the examination of a patient it is essential that the exact site of each of these hyperesthetic areas should be determined by actual inspection and touch. The existence of any irregularity should be sought for and remedied. When, however, the affection persists without apparent pathological conditions in the nose, we must conclude that the afferent nerves of the parts are oversensitive to stimuli and that this phenomenon must be the object of our attack.

We should endeavor to calm the nervous excitability, if possible, and the most efficient means of accomplishing this end is by the sedative action of the constant current. A metal electrode—an ordinary probe will serve—should be made the anode, and a current of 1 to 2 milliamperes should flow through the sensitive areas for a period of 1 minute. Several areas may be treated thus at a single sitting. The cathode is best applied to the cheek or outer aspect of the nose on the same side. The treatment should be given three times a week. Massage, vibratory or labile, with the wrapped electrode will serve as an adjuvant. The general health of the individual, his diet, sanitary surroundings, and general comfort must, of

course, be looked after where possible. He should be kept free from irritating atmospheres even at the expense of a temporary suspension of his labor or profession.

133. It must be admitted that all agents fail to alleviate in some instances. When every means, including internal medication with suprarenal extract and change of scene, has failed, it is well to resort to operative procedure with the electrocautery. The physician must know the location of the sensitive areas and designate two or three for operation. When the

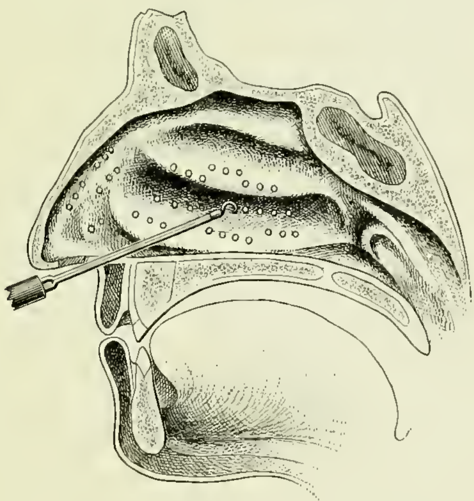

Fig 57

Designating the Areas Ordinarily Requiring Cauterization in Hyperesthetic Rhinitis

nasal chamber has been thoroughly cleansed and cocainized, the operator will select a platinum electrocautery loop or blade of small size and control the current in such a manner as to heat the loop instantly to a white heat. With the nares dilated and protected by a speculum the tip is introduced cold and brought near the area to be first treated. It is well to give preference to the anterior area so that a hyperesthesia there may not operate against posterior examinations and treatment. The loop is brought to a white heat, the designated spot lightly touched,

and the loop allowed to cool at once. All that is essential is to sear lightly the mucous membrane, thus destroying the nerve-terminations and obtunding sensibility. Two or three areas may be dealt with at a visit. There may be some reddening and increase in the watery secretion for a day following the cauterization, but the suffering is not increased, rather, the patient is relieved by the treatment. Two applications in a week are all that may be tolerated. All the areas should be touched before treatment is suspended and it may be necessary to sear some of them a second time. In Fig. 57, the usual sites for cauterization are indicated by the small circles. After-treatment is confined to thorough cleansing with warm salt-water and protecting the parts with an oily spray, which should be applied with an atomizer twice daily by the patient himself.

POSTNASAL CATARRH

134. A chronic inflammation of the posterior nares and the crypts about the vault of the pharynx will generally yield to routine measures. Proper hygienic conditions, tonic medication, the use of the postnasal douche, and insufflations and the correction of any irritating local cause will usually suffice to bring about permanent relief. A few cases, however, demand more summary dealing. It has been observed that in cases where the tissues remain persistently flabby and anemic, and where the discharges continue thick and purulent in spite of local medication, the light application of the electrocautery is very efficacious. A special cautery-tip is required, one that has the blade or loop shielded by a metal guard. Such an instrument is essential in order that the surrounding parts may be protected from the heat of the cautery. A tip such as just described, and known as *Sajous's tip*, is shown in Fig. 58. The method of application may be briefly outlined. The nasopharynx should be very carefully cleansed by means of the douche and any adhering patches of mucous or crust wiped

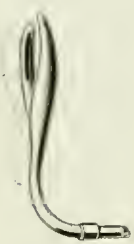

FIG. 58

Sajous's Cautery-Tip and Shield

away. The rhinoscopic mirror will show the areas to be treated and will permit of their direct cocainization. Introduce the cautery-tip cold and with the mirror still in position, bring the blade close to the area to be burnt. Now bring the tip quickly to a white heat and lightly sear the tissues forming one of the crypts (see Fig. 59). The instrument is withdrawn

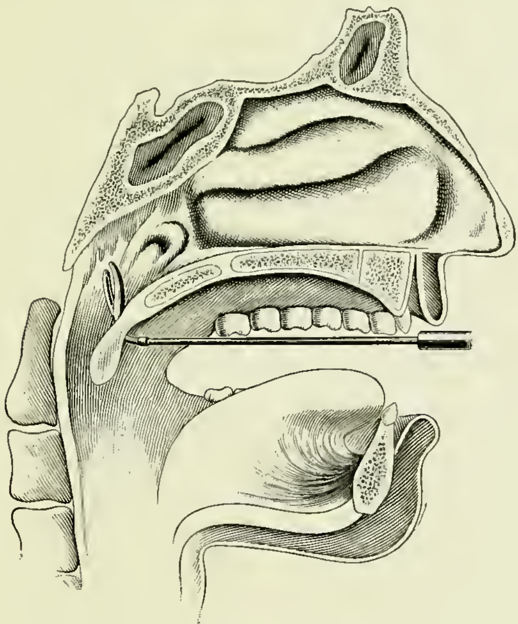

FIG. 59

Illustrating the Method of Applying the Electrocautery to the Nasopharynx

cold. Prior to cauterization, observe that the shield protects the surrounding parts. The reaction is very slight. The cauterization may be repeated biweekly until the secretions have become modified and the tissues take on a more normal and elastic appearance. Night and morning douches with warm saline- or borax-solutions constitute the after-treatment.

NEOPLASMS OF THE NOSE AND NASOPHARYNX

135. Malignant growths, such as cancer and sarcoma, of the nasal cavities, fortunately, are rare. Sarcomata frequently invade the nose by extension from the orbit and bones of the face, while carcinomata may originate in the epithelium of the nasal passages. The treatment of malignant growths consists in their free and early removal. The diagnosis is of prime importance, since if allowed to progress, the tumors soon invade territories difficult of access or entirely inaccessible to operation. The limited space in which we are obliged to work is a factor that leads us to abandon the knife and resort to either of two procedures—the electrocautery or electrolysis. The former is applicable in small growths, the latter in tumors of large size. The cautery-tip should be fashioned like a knife-blade and must be applied at a white heat, removing thoroughly all the infected tissues. The base of the growth is then to be carefully seared with the tip at a cherry heat, to prevent subsequent hemorrhage.

136. In malignant growths of a size too large to subject to cauterization, electrolysis will be found most serviceable. It matters little whether the growth be pedunculated, a rare condition, or sessile. A great temptation is afforded in either contingency to resort to the cold snare or the electrocautery-snare. Such procedure is scarcely to be recommended, for the reason that the growth is seldom, if ever, entirely removed, and recurrences are the rule. Electrolysis is performed in the usual manner, using the bipolar method. After thorough cleansing and cocainization, iridoplatinum needles, straight or curved, are introduced well beneath the base of the tumor, about ¼ inch apart. It is a matter of indifference which needle is made the anode and which the cathode. A current of 5 to 15 milliamperes is allowed to flow for 5 to 10 minutes. In small sarcomatous growths equal success will follow the unipolar method, making the anode the active electrode and applying the cathode to the cheek or shoulder. The current-strength and duration of the operation are about the same in each case. More than one sitting is usually required, and an interval of 4 days should elapse between the electrizations.

Thorough cleanliness and soothing douches should follow each operation.

137. In cases where malignant disease has reached a stage where radical measures are impracticable, or else declined by the patient, the operator has two resources still at his command. One is the employment of the mixed toxins of B. prodigeousus and B. erysipelatus, after the manner indicated by Coley. The cases benefited by this treatment are limited to sarcomata. The other resource is zinc electrolysis. Spherical electrodes of pure zinc are made the anode and brought in contact with the infected tissues. General anesthesia is necessary. The current-strength should not exceed 25 milliamperes. The effect of the galvanic current itself is augmented by the caustic action of the oxychlorid of zinc, which is diffused in the tissues during the process.

NASAL POLYPI

138. Nature.—Of the growths known as *nasal polypi*, we shall deal with both varieties, the myxoma, or mucous polyp, and the fibroma, or fibrous polyp. The points of difference pathologically between the two are of little practical importance to us beyond the indications for treatment that each suggests. The diagnosis requires no comment since these masses present slight resemblance as to appearance or location to growths of other nature. The manipulative skill required in the removal of polypi is considerable. The tumors are situated frequently in parts difficult of access, and unless one is skilled in the handling of postnasal affections the operations about to be suggested had better be referred to others. The surgeon is to be called in where the polyp is sessile and attached to the superior portions of the nasal cavity. Radical operations only are indicated in such cases and where the size of the mass renders ordinary procedure inadequate.

139. Treatment.—The means at our disposal in the treatment of polypi are, briefly, medicinal and surgical. The former consists in the application of astringents to produce a withering and contraction of the tumor, or the injection of drugs, such as carbolic acid, calculated to produce a similar effect. It

is serviceable only in polypi of a mucous type and is at best a palliative measure. The latter embraces the removal of the growth by means of evulsion, the cold snare, the electrocautery-snare, or electrolysis. Of these methods, the two last mentioned are the best.

Pedunculated polypi are treated in the following manner: The nasal cavities are thoroughly cleansed and cocainized. With the parts thoroughly illuminated the electrocaustic irido-platinum snare is introduced cold and slipped over the mass and drawn well down toward the base of the pedicle. As soon

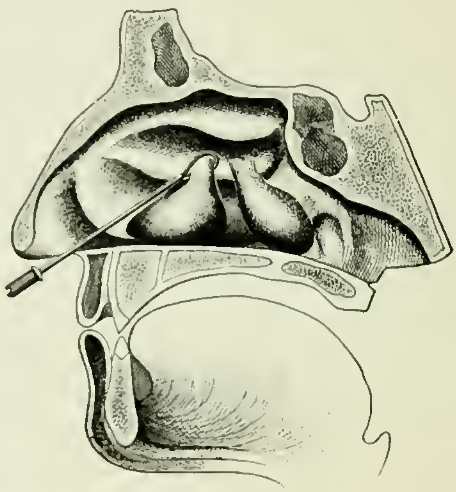

FIG. 60

as the loop is in position (see Fig. 60), the current is turned on for an instant to fix the snare in position. The circuit is now broken and the snare tightened a trifle. Alternate periods of glowing and tightening effect a safer removal of the tumor than instantaneous tightening or traction. Scheppegrell's snare, having a rheostat in the handle that prevents fusion of the shortened loop, is a serviceable instrument for such work.

The cautery-snare may be employed in sessile growths, using Jarvis needles, similarly to the method used in dealing with posterior hypertrophies. A plan equally advantageous, though

slower, is electrolysis, and this method is the operation of choice with many specialists, in fibrous polypi. The bipolar method is to be preferred, using long, lance-tipped, iridoplatinum needles, straight or curved, according to the position of the mass. Several sittings of 10 minutes each, with alternating periods of rest, are necessary. The strength of current need not surpass 25 milliamperes, though some operators have used as high as 90. If the electrocautery-snare is used in the ablation of growths that are sessile or have a broad peduncular attachment, it will be well to follow the method just mentioned, that is, of alternate glowing and tightening. By so doing one obviates the danger of hemorrhage and the necessity for subsequent cauterization of the base. If a polyp be removed by traction with a loop at white heat, it will be safer to sear the base with the electrocautery-tip at a cherry heat. The preliminary application of a solution of adrenalin hydrochlorid is a rational prophylactic measure. One need not work hurriedly. The length of time of an operation for the removal of polyp may be prolonged for an hour with entire safety and without inconvenience. It is much better to spend 1 hour in the operation itself rather than 2 hours at a later period in counteracting the results of hurry. Two or more small pedunculated growths or one large one may be removed at a single sitting. When electrolysis is used the sittings, of course, will of necessity cover a longer period. The after-treatment consists merely of meeting the indications that may arise. The complications that are possible seldom follow good technique and antiseptic routine. Mild cleansing and protective douches and sprays are generally sufficient. General tonic treatment is important.

DISEASES OF THE SEPTUM

140. The tissues covering the bony and cartilaginous portions of the septum are naturally susceptible to the affections that implicate the neighboring parts and are generally involved with them. The therapeutic measures directed toward the amelioration of all nasal affections apply equally well, as a general rule, to diseases of the septum. An exception is to be noted

in the case of the cautery. This instrument has a limited sphere and must be used with caution. The septum is so thin that perforation is prone to follow the use of any escharotic. The cautery is indicated in cases of hemorrhage from ulcers situated anteriorly, and in hemorrhage from this locality not attributable to disturbances of circulation other than local. The cautery-tip should be applied lightly, at a cherry heat, always under thorough illumination and through a speculum. Also, in thickenings over the part usually spoken of as the *tubercle* the cautery may find a place. Two or more light linear streaks may be made in the tissues with the platinum tip at cherry heat.

141. The agent that affords the most favorable results in the treatment of *septal spurs*, ecchondroses, and in *thickenings* that frequently accompany deviation of the septum, is electrolysis, and its utility deserves a wider recognition. Bipolar electrolysis is better adapted to these conditions than unipolar, since the latter is occasionally followed by perforation of the septum. The best results undoubtedly follow the use of iridoplatinum, copper, or zinc needles. These should be properly insulated so that tissues contiguous to the part to be treated need not undergo electrization. The needles are introduced $\frac{1}{8}$ to $\frac{1}{4}$ inch apart near the base of the spur or enlargement in a direction parallel to its long axis. If the mass be of large size, each electrode may consist of two or three needles mounted in the same handle like a hemorrhoid needle. Preliminary cleansing and cocainization are essential and adrenalin may be applied if bleeding is feared. Usually it is not necessary. A current of 5 to 15 milliamperes, gradually attained, should pass for a period of 10 minutes. Intervals of 4 days between sittings must be allowed always, and during this time the nasal passages must be kept thoroughly clean. The spur usually drops off after a fortnight. Bony spurs and exostoses are, of course, uninfluenced by the treatment.

142. Ulcers of the septum from causes other than specific are stimulated to healthy granulation by the use of cupric cataphoresis. A needle of copper may be introduced beneath

the floor of the ulcer, provided the lesion be superficial, or a bulbous tip of pure copper may be brought directly in contact with the ulcerated surface. The anode is the active electrode in either case, and the current-strength should gradually be augmented to 10 milliamperes. The sittings may be of 5 to 8 minutes in duration, and intervals of 3 days between visits should be allowed, during which time the parts must be kept clean and protected. When the entire floor of the ulcer bears a red appearance and shows healthy granulations everywhere, the active treatment should cease and the cleansing and protective agents employed until new epithelium covers over the defect.

EPISTAXIS

143. The etiology and treatment of nasal hemorrhage are so familiar as to require no comment. Of special utility, particularly in cases due to ulceration and in active arterial flow, is the electrocautery. The tip heated to a cherry red should be applied directly to the bleeding-point, never blindly. When recurrences follow, the ulcer is to be subjected to cupric electrolysis as previously indicated.

144. Faradism will be found serviceable in *anosmia* where the condition depends on hysteria or causes which do not interfere with the integrity of the olfactory terminations. The cathode is applied to the bridge of the nose or to the mucosa by means of a double metal electrode well covered by moist cotton. Faradism is useful also in *hysterical sneezing*. The sensitive spots on the mucous membrane are to be covered by a suitable electrode and a mild interrupted current allowed to flow for a short period of time.

Considerable interest has recently been aroused by the statements of the French specialists that dysmenorrhea may be relieved by treatment directed toward certain sensitive areas, called *uterine spots*, in the nasal mucous membrane. It is too early to form conclusions in regard to this claim, but if it be substantiated by future investigation, it cannot fail to be of interest to the specialist in rhinology.

DISEASES OF THE PHARYNX

ADENOID VEGETATIONS

145. Nature.—We have previously spoken of posterior nasal catarrh and indicated a rational plan of treatment. We now have to deal with a condition regarded by some as a sequel, and certain it is that pharyngeal adenoids may frequently enough be traced to preceding colds. The marked similarity of the lymphoid glandular structures in the pharynx to the tonsils renders them liable to processes similar to those which the latter undergo, and inspired Luschka to give them the name of pharyngeal tonsil. Glandular tissue is slow to resolve from an inflammatory affection and continued exacerbations lead on a chronic state accompanied by thickening and hypertrophy. Various dyscrasia may possibly influence the trouble to some extent, an observation which finds some confirmation in the fact that young persons in whom vitality is at a low ebb are most prone to the disorder. The symptoms are classic and its diagnosis easy. Direct inspection may give way to the diagnostic finger in children and the presence of the worm-like cushion is pathognomonic. Many writers urge the propriety of allowing the hypertrophy to exist unmolested until mature years have exercised a diminution in it. Such advise is scarcely to be adopted, since the presence of hypertrophies in the vault is a constant menace to hearing and the general health.

146. Treatment.—The treatment consists in the removal of the vegetations. This is successfully and easily accomplished by so many different plans of procedure that no specific statement can be made as to which plan is the best to adopt. One must rather be influenced by the demands of a particular case and avail himself of the one best suited. In children the growth may be scraped away by the aid of the finger-nail or by the pharyngeal curette. These maneuvers are wholly adequate. In older patients where the pharynx may be inspected with the aid of the mirror, we may resort to removal of adenoids with the cold snare, the electrocautery-snare, or the electrocautery. Whichever of these agents is made use of the operator must

bear in mind the relations of the structures in the pharynx, and avoid injury to the Eustachian orifice and other tissues. Where the tonsil is hard and well organized, the cold snare or the electrocautery will serve best. We are of the opinion that the electrocautery-snare should be reserved for cases where the growth is small and can be handled under direct inspection. Large adenoids may be reduced by the electrocautery, using a guarded tip, such as shown in Figs. 58 and 59. The method of using the various agents referred to, does not vary from general plans. If the galvanocautery-snare be used, the operator should practice the method of alternate periods of glowing, tightening, and rest, which has been previously alluded to. If the electrocautery be employed, it must be applied thoroughly under perfect illumination. The cold tip is brought close to the vegetation, and the parts to be seared touched in different places for practice. Note that the shield protects the surrounding structures. Rapidly bring the tip to a cherry heat and hold it firmly in contact with the mass for a second. Then move the tip slightly to a new portion and sear as before, reducing the entire vegetation in this manner before breaking the circuit and withdrawing the instrument cold. Preliminary cocainization is necessary. Hemorrhage seldom results. The application of a solution of adrenalin will check any oozing that may occur. No after-treatment is required beyond a mild antiseptic douche twice daily. Adenoid vegetations have been treated by the electrolytic current by certain operators, who claim that all adenoid tissue which can be reached by needles should be electrolyzed. While it is true that curved needles will reach the masses under discussion without difficulty, nevertheless, the cautery offers the more speedy and equally as thorough means of relief.

NASOPHARYNGEAL POLYPI

147. Nature.—Nasopharyngeal polypi are not common. The condition is, however, frequent enough to warrant a brief discussion. The polypi in this locality are invariably of the hard or fibrous type, taking origin from connective tissue either in the periosteum itself or structures covering it. They

give rise to symptoms that resemble an aggravated form of adenoid hypertrophy.

148. Treatment.—Total removal of the polyp is the only rational plan of treatment. The situation of the growth will determine in a measure the mode of attack. Some polypi are accessible to the electrolytic needle, and when this is the case the operator had best resort to it. If it be found that bipolar electrolysis is possible, the iridoplatinum needles, properly insulated, may be passed into the growth as near the base as possible, and a current of 5 to 15 milliamperes be permitted to flow for 10 minutes. Sittings may be held on every third day until the entire base of the polyp has been electrolyzed. If monopolar electrolysis alone is possible, the cathode should be made the active pole and the anode placed on the back of the neck. A current of 5 to 8 milliamperes is sufficient.

Where, for any reason, the operation by electrolysis is ill-advised, the physician may avail himself of the cold snare. The location of the tumor will determine to a large extent the choice of snares and the avenue of aceess. Some tumors may be reached through the nose alone, others through the mouth. The cautery-snare should never be used in localities where the Eustachian orifice is endangered, the cold snare then being preferred.

To adjust the snare to the polyp presents some difficulties, but it may be accomplished by working through both the nose and pharynx when it is impossible to grasp the polyp through either passage alone. Scheppegrell's snare is very serviceable. The mass should never be removed hurriedly or by traction. Periods of glowing and tightening and rest should alternate. As in the ease of nasal tumors, 1 hour is none too long for such an operation. Where the cold snare is used, the base of the amputated mass may require a touch of the electrocautery at cherry heat. Treatment which is directed toward the reduction of polypi, by causing suppuration in the pharynx, cannot be too strongly condemned. The parts require no special attention following the operation. Cleansing solutions may be gently applied if desired.

MALIGNANT TUMORS OF THE PHARYNX

149. Malignant tumors of the pharynx may be treated by removal with the knife, écraseur, or electrolysis. The last is most applicable in hard growths. The snares are not to be relied on, because of the difficulty in removing all of the diseased tissue. Cupric or zinc electrolysis is recommended in advanced cases together with the treatment by toxins. The technique of electrolytic treatment does not differ from that in malignant disease elsewhere. The bipolar method is preferable.

ATROPHIC PHARYNGITIS

150. Nature.—*Dry sore throat* is a frequent companion of mature years, in which case it is an affection difficult to shake off. At an earlier period of life greater probabilities of a cure are vouchsafed but realized only after patient effort. The morbid anatomy, embracing the conditions of functionless, glandular structures, diminished vascular supply, and general tissue-atrophy, should prompt us to a rational plan of treatment.

151. Treatment.—The essentials of treatment consist in freeing the pharynx from adherent secretions, the lubrication of the parts, and the stimulation of the tissues to increased vascularity and greater functional activity. The first two of these indications may be met by appropriate sprays and douches. The solutions should contain ingredients that promote the solution or softening of dried secretion and favor the maintenance of a moist condition. Bicarbonate of soda and chlorate of potassium fulfil these requirements. The last-mentioned indication—the stimulation of the parts—is best met by the appropriate use of drugs, such as 10 to 15 grains of silver nitrate to 1 ounce of water, or a 50-per-cent. solution of iodin, or glycerin, or albolene, together with the applications of the galvanic current. Two metal electrodes, guarded by moist cotton, are introduced into the pharynx either through the mouth or one through the nose and the other through the mouth, and held in contact with the pharyngeal wall. A

current of 2 to 10 milliamperes is allowed to flow for 10 minutes. One electrode should be kept stationary, preferably the anode, and the other moved from place to place. It is not advisable to break the contact when shifting the electrode unless the current is first diminished. The galvanic treatment may be given daily. At the close of the sitting, inspection of the parts will usually show a vivid red color and an abundant secretion. Electrization by means of a long, curved electrode (cathode) submerged in water, which is held in the pharynx, has been recommended, but the tendency to swallow is usually so strong as to render the plan inadequate. As before mentioned, the results of treatment depend largely on the age of the patient. To afford relief alone, without the prospect of a cure, the treatment must, in old persons, be persistent. Patients young in life may be cured, but only after prolonged periods. It is scarcely necessary to add that the patient must accept all admonitions as to habits and adopt measures calculated to promote the general health.

FOLLICULAR PHARYNGITIS

152. Nature.—The name of *clergyman's sore throat*, which is sometimes given to this affection, suggests to us a factor in etiology that is abundantly substantiated by every-day experience. The overwork of the vocal apparatus together with its faulty use, perhaps, and the existence of a nasopharyngitis that bathes the parts in irritating secretions, are causes which excite the disease. The strain put on the glandular elements of the pharynx, in the effort to furnish lubrication sufficient to keep the speaker's resonance-chamber moist and smooth, manifests itself in an inflammation of the glands. The ducts become blocked and cheesy secretion accumulates, causing red, white-tipped elevations on the fauces and pharyngeal walls. The tissues become congested and the blood-vessels dilated. In some instances these little elevations or follicles burst and discharge their whitish contents, which cling to the mucous membrane in masses, but may be easily wiped away. Such a condition has given rise to the

use of the name *exudative* pharyngitis in distinction to *hypertrophic*, which latter is the same affection with unbroken follicles. There is little use for the preservation of these terms. The symptoms of this disease require no mention. In young and middle-aged persons the complaint may be cured. When it occurs in old subjects, an instance comparatively rare, the outlook for permanent relief is unfavorable.

153. Treatment.—The complete destruction of each inflamed follicle and the evacuation of its contents constitute the essentials of treatment. Of the various means of bringing these about but two of the best will receive mention—cathodal electrolysis and the electrocautery.

The throat is at first cleansed with a mild alkaline spray, and all adherent secretions are gently wiped away with a cotton swab. A special electrode carrying two iridoplatinum needles insulated to within $\frac{1}{4}$ inch of the tip is required. This instrument is made the cathode, and the anode is placed on the back of the neck. The needles are introduced deeply into the center of a follicle, and a current of 10 to 12 milliamperes is made to pass for 1 minute. A whitish, cheesy exudate appears at the site of puncture, which may be wiped away. This plan of treatment is most excellent, and its only inconvenience is the amount of time consumed.

154. A more speedy method of dealing with the follicles, and one equally as effective and painless, is by reducing each elevation with the electrocautery. An ordinary platinum loop twisted into a rope will serve for a tip most admirably. After the throat has been cleansed, the cautery-tip is brought to a cherry heat and plunged deeply into a follicle and immediately withdrawn. Half a dozen of the follicles may be punctured at a single sitting. The cautery not only destroys the follicle, but also removes and disposes of its contents. After the tiny operation each follicle looks whitish with a rosy areola of inflammation about it. The reaction amounts to nothing, and the patient speaks of a mild sore throat for a day or two. After an interval of 3 or 4 days the treatment may be continued until

all the little elevations have been destroyed. The pharynx should receive daily cleansing sprays of some alkaline solution and protective and lubricating sprays of oil. New crops of enlarged follicles call for puncture with the cautery. The relief afforded by this treatment is very great. Hygienic and constitutional treatment should never be neglected.

PHARYNGEAL ABSCESS

155. Pharyngeal abscess may be incised by means of the electrocautery with far greater safety and better results than with the bistoury. A tip consisting of a platinum blade may be used. The abscess should be incised near its most dependent part to facilitate drainage. The incision should be of extent sufficient to warrant its remaining patent. If the quantity of pus is large, preliminary aspiration is recommended.

PHARYNGOMYCOSIS

156. In the rare instances where the leptothrix fungus finds lodgment in the pharynx, very radical measures are called to eradicate it. The various foci of growth require to be destroyed by the electrocautery under cocain anesthesia. Even this drastic measure sometimes fails, in which cases cupric electrolysis should be afforded a trial. The diffusion of cupric oxychlorid that accompanies anodal electrolysis is fatal to the life of the fungus.

PARALYSIS OF THE PHARYNX AND SOFT PALATE

157. Nature.—Muscular paralyses of the throat may be due either to central nervous disease or may constitute a factor of systemic disease. On the etiology depends the prognosis to a large extent. Diphtheritic and allied palsies are wont to recover entirely, while paralyses dependent on central disease seldom, if ever, entirely recover. The character of the palsy, whether spastic or atrophic, depends on which neuron is involved, and

may be determined readily by subjecting the muscles to faradic stimulation. A muscle undergoing atrophy will not respond, while a muscle governed by a healthy upper neuron will react to the stimulus. Much improvement may be looked for in the latter condition, particularly if the process be part of a hemiplegia, but in the former no treatment is of avail.

158. Treatment.—Treatment consists in stimulating the muscles by means of cathodal electrization with the constant current. The active electrode may consist of a metal plate or sound well wrapped in moist absorbent cotton. This electrode is brought directly in contact with the tissues, while the anode is placed on the back of the neck. Mild currents are best. Interruptions of the current are occasionally serviceable. The therapeutic measures recommended in the treatment of atrophic pharyngitis are applicable to this condition also. Where the velum palati is involved in the palsy the cathode may be immersed in water held in the throat. In diphtheritic and syphilitic paralyses the constitutional treatment should be of prime importance. In nuclear palsies affecting single muscles or a group of them, treatment is of no avail whatever, and measures that tax the strength of the patient are not to be commended.

HYPERTROPHY AND ELONGATION OF THE UVULA

159. In cases of moderate elongation of the uvula giving rise to cough and pharyngeal irritation, the application of the electrocautery, at a cherry heat, to the posterior surface will produce a contraction of the organ sufficient to allay the symptoms. Where the hypertrophy and elongation are extensive, cauterization must give way to amputation. Cocainization is advised. The tip of the uvula should be caught with forceps and drawn forward before the cautery is applied, so as to check the elevation of the uvula and to avoid injury to the surrounding tissues. Simultaneous injury to the posterior surface of the uvula and the posterior wall of the pharynx may result in synechia.

DISEASES OF THE TONSILS

HYPERTROPHY

160. Nature.—Pathologically considered, the faucial adenoids resemble the pharyngeal tonsil referred to previously. The tendency of lymphoid tissue to undergo hypertrophy and take on a growth of fibrous tissue is well known. This process is called organization, and up to a certain limit appears to increase with age. In children, the hypertrophied tonsils are seldom hard, while in young adults the hardness, which may be taken as a degree of organization, is at its height. In mature years and old age the tonsils tend toward absorption, a fact which accounts for the cases of "outliving the trouble." Were it not for the systemic disturbance that these adenoids create, and the complications that follow, the masses might be left to undergo spontaneous absorption with age, but the existence of a constant menace to health should not be tolerated, since the battle is too frequently won at the expense of constitution. The morbid anatomy and symptoms of the affection are too familiar to excite comment. The indication that confronts us is met by the removal of the hypertrophied masses, together with due attention to the general health and hygienic surroundings of the patient. A rheumatic diathesis may be suspected, and the family history may throw some light on this problem.

161. Treatment.—We have a strong conviction that the details of the operation for the removal of enlarged tonsils should differ radically according to the age of the patient. In children, the masses are generally soft, although they may attain enormous size. Where this absence of induration exists we possess a reasonable assurance that organization has not progressed to a marked degree. These soft adenoids are best removed by means of the tonsillotome or guillotine. The hemorrhage following is very slight and the mouths of the severed blood-vessels quickly contract and close. The operation itself is speedy and almost painless. The condition is changed, however, in young adults. Here we have a quantity of fibrous tissue, which supports the blood-vessels and tends to keep them open when severed. The

masses feel hard and resilient to the touch. It is by no means claimed that the removal of hypertrophied tonsils in young adults is always followed by hemorrhage. Indeed, this complication is rare. The tendency toward hemorrhage, however, is invariably present, and sooner or later the operator will have his turn in the treatment of the complication. An experience with sharp bleeding after the removal of adenoids with the knife or guillotine in young adults will prove conducive toward caution and will not be easily forgotten. The safest plan of procedure is the ablation of the masses by means of the electrocautery-snare. To be sure, the operation requires a longer time than the guillotine, but the tendency to hemorrhage is vastly diminished. The parts are thoroughly cleansed and a 10-per-cent. solution of cocain applied. If the tonsil is hidden by the pillars to an extent that interferes with its being readily grasped by the snare, it should be transfixed by a needle and brought into the field by light traction. The snare should be manipulated with a view to alternate intervals of glowing, tightening, and rest. The electrotonsillotome is operated on a similar principle. The method of treatment by electrocautery puncture is painful and leaves unsightly results, and that of cautery dissection is so slow and painful as to warrant its abandonment.

162. Electrolysis finds a place in the treatment of adenoids where the lymphoid tissue presents the characteristics of diseased structure rather than mere hypertrophy. In malignant disease, also, this therapeutic agent is indicated. Bipolar electrolysis is preferable, using long and properly insulated needles of irido-platinum. Where the growth has progressed beyond a condition where entire removal is possible, the specialist should resort to copper or zinc electrolysis. The electrolytic needles, suitably mounted in a carrier, are introduced into the tonsil near its base and carried on until the point slightly protrudes on the posterior aspect, using a tenaculum or forceps to draw out and steady the mass. It is well to begin near the inferior border and progress toward the superior aspect at subsequent electrizations. A current of 12 to 20 milliamperes may be utilized for 10 minutes

at all sittings, which should occur not oftener than 4 or 5 days apart. The reaction following all operative measures on the tonsils is slight and occasions no trouble usually beyond a slight inconvenience and soreness.

CHRONIC FOLLICULAR TONSILLITIS

163. Chronic follicular tonsillitis, characterized by the enlarged tonsils with their lacunæ filled with white cheesy exudate, the foul breath, cough, the proclivity to recurrent exacerbations of acute sore throat, etc., demands for relief the destruction of the follicles together with the removal of the contents. Analogous to the follicular inflammation of the pharynx in so far as the indications for treatment are concerned, the tonsillar affection affords a striking illustration of the utility of the electrocautery. A platinum tip of a pattern similar to that recommended in Art. **153,** only longer and somewhat thicker, is required. The glowing tip is to be depressed to the bottom of each follicle in turn until half a dozen have been cauterized. The cauterizations may be continued at a subsequent visit some few days later. At the completion of the treatment the disease is cured. Local antiseptic and soothing sprays form a good adjunct to the treatment.

LINGUAL ADENOIDS OR HYPERTROPHY OF THE LINGUAL TONSIL

164. The pathology of this condition is precisely similar to that of an enlarged faucial and pharyngeal tonsil. In making an examination of the throats of young persons the physician should invariably carry his finger to the base of the tongue and behind the soft palate whenever there are indications of faucial adenoids. The reduction of the lingual hypertrophies is best accomplished by applications of the electrocautery at glowing heat under direct inspection so as to avoid injury to the epiglottis. Snares are not to be recommended, and bipolar electrolysis is employed only when the mass is very hard and of large size.

STENOSIS OF THE EUSTACHIAN CANAL

165. Although affections of the Eustachian tube properly fall under the division of diseases of the ear, nevertheless, the subject of the treatment of strictures of this organ is here given for the sake of convenience and because the avenue of access for the exhibition of local measures is approached through the nose and pharynx.

In nearly every case of chronic catarrhal otitis media, the tube is blocked early in its progress. It is brought about simply by an extension of the affection from the middle ear. The term chronic tubal catarrh, under which this process is described, represents an extension then of the inflammation to the Eustachian tube and nothing more. If we inquire into the nature of the pathological anatomy in each location, we will find the changes to be the same. Hyperemia, exudation, and infiltration, followed by more or less organization and submucous hypertrophy, are the features common to both. It cannot be gainsaid that the affection may be confined to one or the other organ alone. When it exists in the tube, whether the tympanum be implicated or not, the result is deafness, and the deafness is functional or not, depending on the integrity or involvement of the middle ear. If occlusion of the tube exists alone, the functional deafness will be remedied by rendering the canal once more patent. The importance of relieving an obstruction of the tube is realized when we are taught that stenosis is one of the prime causes of middle-ear disease when that organ is not yet affected, and the cause also of still further trouble if disease already exists.

166. Let us now suppose that we have a stricture of the tube, which is due to exudation and infiltration, i. e., organized. By what plan of treatment may we obtain the most efficient and lasting effects? Electrolysis fulfils these requirements to a degree better than any other agent that we possess.

The method recommended is that of Bordier, which may be briefly outlined. The specialist should be provided with a graduated set of copper bougies ranging from 3 to 6 of the French scale, mounted on No. 5 or No. 6 copper wire. These

are so fashioned as to fit into ordinary silver Eustachian catheters, which are insulated from tip to mouth. The bougie is to be pushed full length into the catheter until its copper tip protrudes slightly in the opening (a), Fig. 61. The catheter

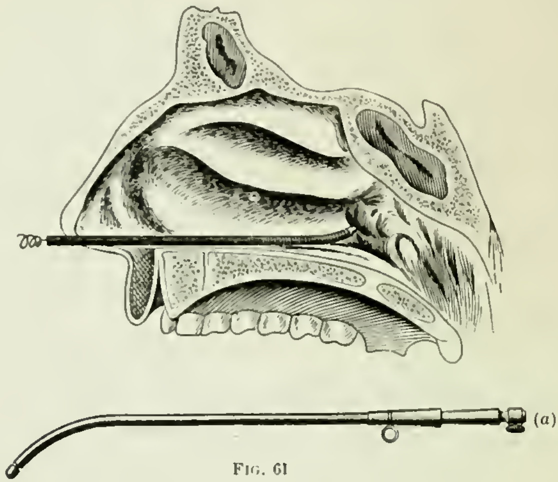

Fig. 61

is now introduced into the tube in the usual manner and carried along until the tip meets the obstruction, Figs. 61 and 62. The wire is then attached to the cathode terminal of the current source and from 2 to 5 milliamperes is passed for 2 to 5 minutes. The operator will now observe that the bougie passes on with greater ease. More of it, therefore, is pushed in and the same quantity of current is administered for 5 minutes. At the end of this time the catheter and bougie are withdrawn together. Duel uses bougies of gold of a length sufficient

Fig. 62

to allow protrusion for $1\frac{1}{2}$ inches or more beyond the tip of the catheter. This arrangement permits the electrization of the entire canal at once. Better results are gained by the employment of weak currents for a longer period of time than by using strong currents for a brief sitting. It is understood, of course, that electrolysis alone does not constitute the entire treatment. Routine measures with insufflations, etc. are to be carried out

concomitantly. The sittings should be repeated as often as twice weekly, using a bougie of larger caliber on each occasion, if possible. Daily catheterization and insufflations are advised during the intervals. The middle ear should receive proper attention. Even if it be impossible to restore hearing by the reduction of the stricture, the tinnitus which is so commonly present and so persistent is very frequently entirely dispelled.

DISEASES OF THE LARYNX

167. The diseases of the larynx that are amenable to electrical treatment are not numerous, but they require the highest degree of manipulative skill on the part of the operator. It is imperative that he should be perfectly familiar with laryngoscopy (see Fig. 63), with the method of making applications to the interior of the organ, and accustomed to the use of laryngeal instruments. The area in which one must work is very small, and whatever operation is done it must be performed under full illumination and inspection. The cautery finds a limited application in this field. Its use is prone to occasion edema or to be followed by cicatricial contraction, a sequel which entails serious consequences if it occurs about the ary-epiglottic folds or the interarytenoid space. The indications for the use of this instrument will be mentioned later. Electrolysis is serviceable and may be used on any tissue of the larynx that can be reached by properly insulated needles. Of late years,

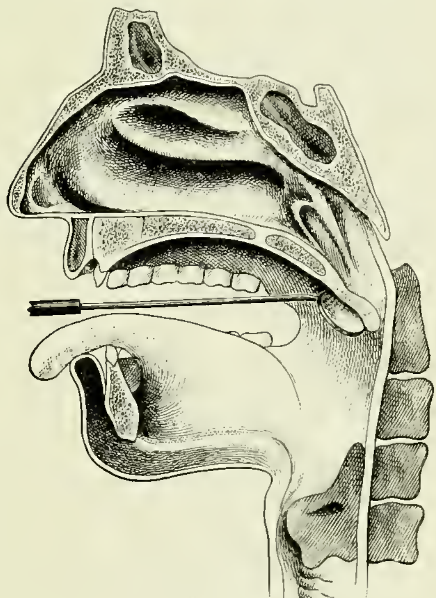

FIG. 63

Showing Position of the Laryngoscopic Mirror

cataphoresis has taken a high therapeutic position. Its use is commended, and it is hoped that it will find a more general reception. Faradism is useful in certain motor affections of the larynx and as a stimulant to the tissues following treatment for tumors, syphilis, etc.

TUBERCULOSIS

168. While this condition, generally, is secondary to foci of infection elsewhere, as for instance in the lungs, the fact remains that not infrequently the laryngeal focus is the primary one. It is of the utmost importance, therefore, that an early diagnosis be made and appropriate treatment instituted at once. Cupric cataphoresis as suggested by Doctor Scheppegrell, of New Orleans, is the method of treatment that offers the greatest encouragement. It possesses advantages over the cautery, the curette, and electrolysis, in that there is no inflammatory reaction, no secondary bleeding, and no wounding of the tissues, thereby to open up fresh avenues for infection. An exception is taken in the case of very hard diffused masses of infiltration in and about the ventricular bands. These yield best to unipolar cathodal electrolysis with a current of 10 milliamperes for 5 minutes at a sitting. Their position renders them tolerably easy of access.

In the treatment by anodal electrolysis, laryngeal bougies tipped with pure copper are used. The larynx is first cleansed and then anesthetized with a 10-per-cent. solution of cocain. The indifferent cathode is placed on the back of the neck. The bougie, which is made the anode, is introduced into the larynx by the aid of the lamp and mirror and brought in contact with the diseased area. A current of 0 to 5 milliamperes, gradually attained, is allowed to flow for 1 to 2 minutes. The treatment may be continued after a day of rest. Hygienic and systemic treatment should be carried out faithfully.

TUMORS OF THE LARYNX

169. It is fortunate that the benign tumors of the larynx are by far the most common. The various species of papillomata are most frequently seen, and the angiomata, myxomata,

and cysts less often. Malignant disease, when it makes its appearance in this organ, calls for the most radical of measures, and complete excision offers the only hope in many instances. It will be difficult to lay down hard-and-fast rules for the

Fig. 64
Laryngeal Cautery-Tips and Snares

management of the various laryngeal growths. We will therefore deal generally with the subject, and the student will do well to consult his own experience and judgment in a given case.

170. Treatment. — Cysts and the softer neoplasms, embracing the soft warty or mulberry papillomata and sessile

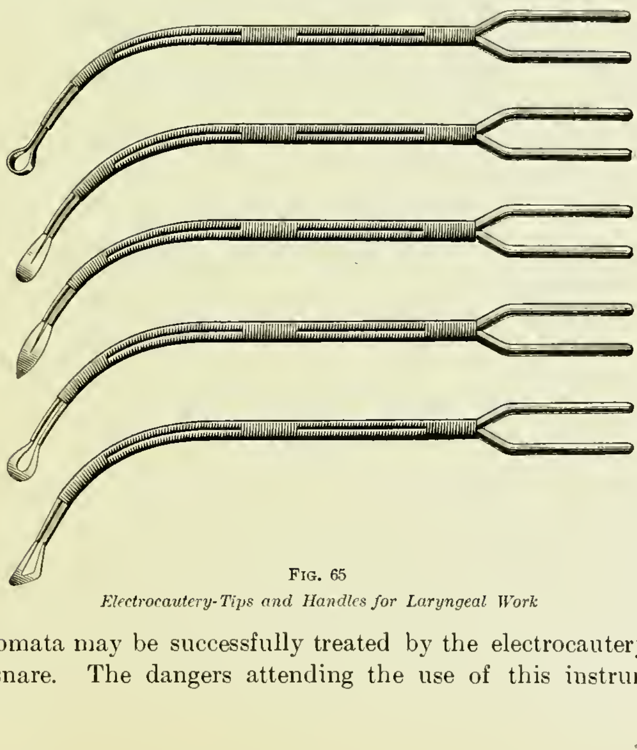

Fig. 65
Electrocautery-Tips and Handles for Laryngeal Work

fibromata may be successfully treated by the electrocautery-tip or snare. The dangers attending the use of this instrument

have been alluded to and should never be underestimated. The most careful manipulation is required. The cautery must be in perfect working order, and the current-controllers and circuit openers and closers must work quickly and smoothly. The apparatus is to be so controlled as to bring the tip instantly to a cherry heat. Some of the laryngeal cauteries in more common use are shown in Figs. 64 and 65. The use of the cautery in

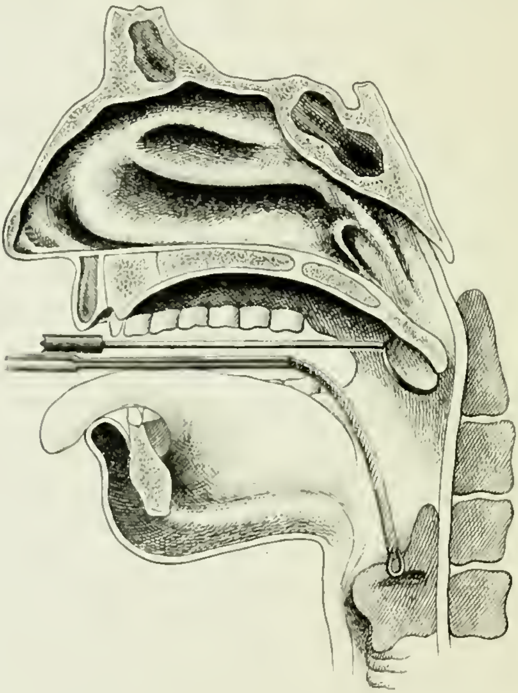

FIG. 66

Showing Position of Mirror and Cautery in Laryngeal Work

the larynx should practically be limited to this class of cases and one other, viz., the treatment of the bases of tumors that have been otherwise removed.

The patient is seated in front of the operator in the laryngoscopic position. Under perfect illumination, the larynx is inspected and cocainized. With the mirror still in position, the curved laryngeal electrode bearing the cautery-tip is passed cold

into the glottis and held for a moment in contact with the growth (see Fig. 66). The operator then slightly carries the tip away from the tumor, closes the circuit, and touches the part to be cauterized once, twice, or three times, lightly and quickly. The circuit is then broken and the instruments withdrawn. Soothing insufflations and protective sprays are indicated following this procedure. There is scarcely any pain, but there may be a marked inflammatory reaction calling for ice-applications and sedatives. An interval of a week should elapse before further operations of this character may be allowed.

171. The hard fibromata, tumors with broad, sessile bases, and malignant growths in their early stages may be treated by electrolysis, provided the growth is accessible to electrolytic needles. Bipolar electrolysis is best, the two short and thoroughly insulated needles of iridoplatinum being attached to a curved laryngeal electrode. The needles are introduced into the tissues near the base of the tumor under full illumination and inspection. A current of 0 to 5 milliamperes, gradually attained, is to be used for 5 minutes or as long as the patient's subjective sense and strength will permit. Weak currents applied for longer intervals of time are not so apt to incite unfavorable reactions as strong currents given for brief periods. Intervals of 4 days should elapse between electrizations.

172. Malignant tumors of the larynx, where for any reason a radical operation is refused and the growth has progressed beyond the aid of ordinary measures, may be treated

FIG. 67

Copper- or Zinc-Tipped Laryngeal Electrode

by cupric or zinc electrolysis, using an insulated electrode tipped with a ball of pure copper or zinc, Fig. 67. This electrode is made the anode, and the cathode or indifferent electrode is applied to the back of the neck or shoulder. The instrument is introduced into the larynx under full illumination with the mirror, and brought into contact with the diseased tissue.

The current should be gradually raised from 0 to 5 milliamperes and the length of the time of the sitting should not exceed 2 minutes. The reaction is very slight and the sittings may be held as often as every second or third day. In growths of a sarcomatous character that have surpassed local bounds and become inoperable, the toxins of Coley should be afforded a trial in conjunction with the treatment just referred to. General tonic measures and attention to the patient's comfort and hygienic surroundings are essential in the management of this class of patients.

STENOSIS OF THE LARYNX

173. It will be unnecessary for us to inquire particularly into the causation of laryngeal stricture, since these factors are so well known. Of greater importance to us are the consequences and the management of the cases. Any degree of stenosis leads to a serious alteration of function, and a considerable narrowing necessitates the creation of an artificial channel for respiration. As in stenosis elsewhere, as we have seen, electrolysis offers the best means of alleviation. Those cases, particularly, in which a cannula is worn in a tracheotomy fistula offer the most gratifying results. An instance is recorded of a complete cure, so far as respiratory function is concerned, in a man who had worn a cannula for 16 years.

174. Treatment.—We may divide the cases of stricture into two categories, those in which a tracheotomy is required and those in which it is unnecessary. In the former class the treatment is simple enough, but in the latter we meet with some perplexing questions. Let us suppose a case of narrowing, in an adult, in which there is developing a submucous hypertrophy and organization, and where the anteroposterior diameter is only 6 or 7 millimeters. In such a case, cathodal electrolysis with an O'Dwyer intubation-tube of copper would offer good prospects of cure without tracheotomy. An intubation-tube adapted to a child 4 years old should be selected. Where, however, the anteroposterior diameter of the larynx is less than 7 millimeters, a tracheotomy preliminary to treatment is advised. For cases wherein tracheotomy is unnecessary,

the operator may make use of copper intubation-cannulæ for electrodes, and where the patient requires tracheotomy or already wears a cannula, a graduated set of laryngeal copper bougies is required.

175. The method is quite similar to that of the electrolysis of strictures elsewhere. Under illumination and inspection the tube or bougie is introduced into the larynx and is made the cathode. The anode is placed on the back of the neck. A current of 5 to 20 milliamperes should be passed through the tissues for 5 minutes. Two days should intervene between sittings. When the caliber of the larynx has attained a size that assures the permanency of the respiratory function, the treatment may be suspended and the tracheotomy fistula, if one exists, closed.

MOTOR AFFECTIONS OF THE LARYNX

176. Motor affections of the larynx are benefited by direct stimulation of the muscles by the interrupted current, using the cathode as the active electrode. The same treatment

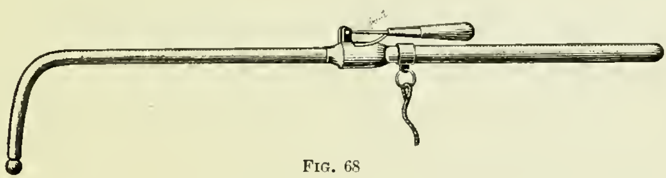

FIG. 68

McKenzie's Laryngeal Electrode

is beneficial following, or as an adjunct to, the treatment of neoplasms, tuberculosis, syphilis, etc. The instrument best adapted for this purpose is McKenzie's electrode, Fig. 68, or some modification of it, as in Fig. 69. The electrode is introduced into the cocainized larynx by the aid of the laryngoscope and brought as closely as possible in contact with the muscles. The strength of current and duration of application must be governed by the patient's subjective senses. Daily sittings are not too frequent. The anode is placed externally over the thyroid cartilage. Methods that are inferior to this, but which may be utilized when, for any reason, it is unavailable,

consist in the external electrization with the interrupted current, placing an electrode on either side of the larynx; or electric

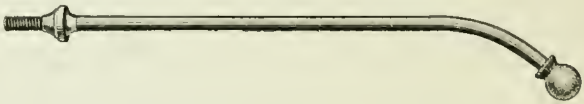

FIG. 69
Modified McKenzie Electrode

massage, making the hand of the operator the active electrode.

NEUROSES AND FUNCTIONAL VOCAL PALSIES OF THE LARYNX

177. Galvanism has received the sanction of many authors in the treatment of neuroses and functional vocal palsies of the larynx, using monopolar or bipolar direct internal or indirect external applications. Of greater value, however, is the interrupted current as used in Art. **176.**

In speakers and singers, galvanism may be useful to stimulate the motor nerves of the larynx, placing the cathode over the posterior border of the thyroid cartilage at the point of entrance of the recurrent laryngeal and the anode at the crico-thyroid articulation. Persons who use their voice to a great extent frequently manifest a hoarseness that would seem to indicate a laryngitis, did not the laryngoscope prove the contrary. It is in such cases that galvanism proves serviceable and should be afforded a trial.

HYSTERICAL APHONIA

178. As an adjuvant to the proper general management of such cases, faradization of the larynx either by direct internal or external methods is serviceable. Galvanism, using rather strong currents with frequent interruptions, or the static spark, may be used instead of faradism. It is claimed by some that the timbre and strength of the voice are aided by the inhalation of ozone generated by the sparks of the static machine or induction-coil. In some healthy individuals ozone is a decided irritant to the larynx and its use should be attended with caution.

Electricity in Genito-Urinary Diseases

ELECTRICITY IN GENITO-URINARY DISEASES

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INTRODUCTION

1. Electricity is the most wonderful force in nature. The progress made within the past few years in utilizing it has been so rapid and effective as to be little short of marvelous. The most recent example of its perfected use was in the lighting of the Pan-American Exposition with a current generated at Niagara Falls. Here was shown such perfect control of a current of prodigious power that there was seen simultaneously in many hundred thousand lamps many shades from but a faint beam of light to the full brightness of the incandescent lamp, likening the effect to the ponderous trip-hammer with power to crush the huge boulder, and yet capable of such fine adjustment as to merely crack the shell of a robin's egg.

It is conceded that there is only one kind of electricity, but its actions vary widely, according to the current and instruments employed in utilizing it. This agent manifests various properties, as attractions and repulsions, chemical decompositions, luminous and heating effects, and many other phenomena. Unlike gravity, it is not inherent in bodies but is excited or induced in them by a variety of causes.

2. But the purpose of this section is to show what electricity accomplishes as a remedial agent in genito-urinary diseases. As great as has been the progress in utilizing this agent in the

other arts, even more wonderful has been the success attending its application in the healing art, and some maladies are now cured by electricity that were formerly not amenable to any medicinal treatment. Its rise in medicine was received a generation ago with much promise of success, but owing to insufficient knowledge and crude apparatus it again fell into disuse. The great majority of physicians discarded it or allowed it to languish in comparative obscurity until the small band of faithful students and investigators had by ceaseless toil overcome difficulties, which now makes it stand forth in a light of success that seems destined to grow brighter and brighter as the days, months, and years beat funeral marches to the grave for less efficient remedies that must now give way forever to electrotherapy.

CURRENTS OF ELECTRICITY

3. The general electrician considers practically only two currents—the *direct* and the *alternating*. But in electrotherapeutics more subdivisions are made according to the voltage, amperage, and quality of current required to meet different indications in disease. The currents used in medical practice are also of two types—direct and alternating—but a distinction is made according to the apparatus from which they are derived. The first may have its source in a primary battery, storage-battery, direct-current dynamo, or static machine. The second type is derived from the physicians' induction-coil, a sinusoidal apparatus, alternating-current dynamo, or a static machine, when a spark-gap is introduced in the circuit.

DIVISION OF APPARATUS AND CURRENT

4. The following classification represents the currents used in the diseases under consideration:

Galvanic Current.—This is derived from chemical cells, storage-batteries, dynamos, and from the commercial circuit.

Faradic Current.—This is an alternating and interrupted current, sometimes called electromagnetic, secondary, or induced current, and is derived from the physicians' induction-coil.

Sinusoidal Current.—This is an alternating induced current without interruptions, and is derived from the sinusoidal apparatus.

Static Electricity.—Frictional electricity, also called Franklinism, or static electricity, is derived from static machines improved by Wimshurst, Toepler, Holtz, and Morton.

A knowledge of physics is necessary to a proper understanding of the principles of these currents, but this cannot be considered in this work, and the student is referred to the first four Sections of this Course.

ARMAMENTARIUM FOR GENERAL PRACTITIONERS

5. General practitioners object frequently to the expense for the apparatus required in the application of electric currents. This would indeed be a serious obstacle if the extensive apparatus used by the specialist were required for effective work. Fortunately this is not the case, as less expensive apparatus may be obtained that will give satisfactory results even in the hands of a beginner. For this reason, we outline below the necessary expense for apparatus from which the general practitioner may expect satisfactory results.

One 20- or 24-cell galvanic battery, pole-changer, and current-controller	$ 30.00
One high-tension coil faradic battery with total length of coil 4,500 to 8,000 feet . . .	50.00
One milliammeter	23.00
Electrodes, conducting-cords, handles, etc. .	20.00
Total	$123.00

This gives the cost, approximately, for good instruments of any reliable maker. From the list we have purposely omitted the old family faradic battery and other cheap apparatus as useless. They have already done much to bring electrotherapeutics into disrepute.

A reliable outfit for illumination and electrocautery-work with the necessary accessories may be added when required at

an additional cost. The armamentarium required for more extended work for the specialist will comprise:

One 20- to 24-cell portable galvanic battery	$ 30.00
One high-tension coil faradic battery	50.00
One cabinet galvanic battery, stationary	150.00
One milliammeter	30.00
Electrodes, in large variety	40.00
One storage-battery	50.00
Total	$350.00

6. The specialist's armamentarium will not be complete unless he adds a good static machine, cystoscope, endoscope, and different electrodes, and possibly a portable electrocautery-apparatus, for operations at a distance from home. Other additions may be made, until $1,000 has been easily spent. We have fitted up two offices at a cost of $2,000, not counting experimental changes and improvements. If fine switch-boards, motors, extra-large static machines, cabinets for light-treatment, Roentgen ray apparatus, etc. are added, any sum may be expended, but these figures should not discourage the beginner, as such outlays are not necessary for a commencement and are needed only in time and in the course of a prosperous career.

When the physician interested in genito-urinary work has procured a good galvanofaradic switchboard adapted to chemical cells or commercial circuits, or both, his purchase of electrodes and other accessories should be determined by the demands of his practice. An initial outlay of $125, or, at most, $150, should provide everything with which to begin his electrotherapeutic work. The thorough electrotherapeutist will do his work with simple and inexpensive apparatus. Physicians purchase medical books from time to time, surgical instruments and other appliances when their practice requires them. Electrotherapeutic apparatus should be purchased in the same manner. An outlay of $150 will purchase the neccessary apparatus to begin work. This apparatus should be thoroughly mastered, both in its construction, care, and management, and in the technique of its application. To do good work with

electrical apparatus, the physician should use them with the same confidence and familiarity with which he uses the clinical thermometer and stethoscope. Complicated, inefficient, expensive, and non-durable apparatus have done more to put back the general use of electric currents in medicine and surgery than the whole hosts of charlatans and irregular practitioners who are so often accused of using electric currents. The student of this section cannot fail to observe that four-fifths of the best genito-urinary electrotherapeutic work is accomplished with a galvanofaradic switchboard and a few simple electrodes.

7. The galvanic battery generally used is composed of cells, elements, and fluid. Under *cell* may be understood an empty vessel for the elements, or a cell complete, containing elements and fluid. The cell proper—the empty vessel—may be made of glass, rubber, or china. The elements consist of a pair of dissimilar plates. The fluid in which the plates are immersed may be of a varied constitution.

The cell complete yields a constant and uniform current under unvarying conditions. This implies that neither the electromotive force nor the resistance of the cell shall vary, or else that as the electromotive force runs down, the resistance shall diminish in proper proportion to maintain a constant current. There is in reality no constant cell. The constancy is greatest when the external resistance is high in proportion to the internal resistance.

Sometimes dry cells may be convenient for the busy country practitioner who takes his battery in his carriage. Of late, these dry cells have been much improved, for his convenience, so that bad roads or clumsy servants cannot upset acid fluid and thereby spoil costly fabrics.

8. Galvanic batteries may be *portable* or *stationary*. The portable battery is composed of from twelve to thirty cells; those consisting of twenty to thirty cells are more commonly used. They produce a constant current as long as the circuit is closed, which means as long as the elements of the portable

battery are immersed in the fluid. As soon as the séance is finished, the elements must be removed from the fluid.

9. We have constructed a portable galvanic battery (see Fig. 1) that keeps clean, and is a convenience, particularly for travel to distant parts.

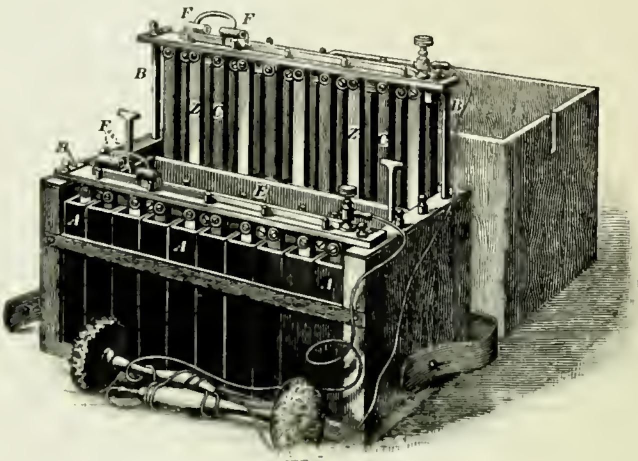

FIG. 1

Newman's Portable Galvanic Battery, Twenty Cells

A, A, A, Hard-Rubber Cells, 20. B, B, B, Corner-Posts. Z, C, Zinc and Carbon Elements E, A Wash-Tray in Which the Elements are Cleaned and Firmly Held for Transportation

The features of this battery are:

1. It can be transported any distance, and a concentrated fluid may be kept separately in a bottle, and, when ready for the operation, diluted, and the cells filled.

2. All parts of the battery are easy of access.

3. If any element is broken, it can be changed or easily replaced, without the aid of an instrument-maker.

4. The elements are cleaned in the dripping-pan after each use, preventing any crystallization on the elements.

5. There is no spilling of fluids.

6. One-half of the battery (ten cells) can be used independently, thereby saving the zincs.

10. Cabinet Stationary Galvanic Battery. — Many different cells are used. The Leclanché cells are now generally employed. A semidry cell recently put on the market is the *Hydra cell.* It presents some advantages over other dry cells in having a very large zinc electrode that is exposed to the action of an energetic depolarizer. This is accomplished by dividing the zinc electrode in two, each in the form of a cylinder, of which one is placed in the interior of the carbon cylinder and the other exterior to same. The carbon is not alone surrounded by the depolarizer, but its exterior cavity is also filled with same. The result is that the depolarizer is

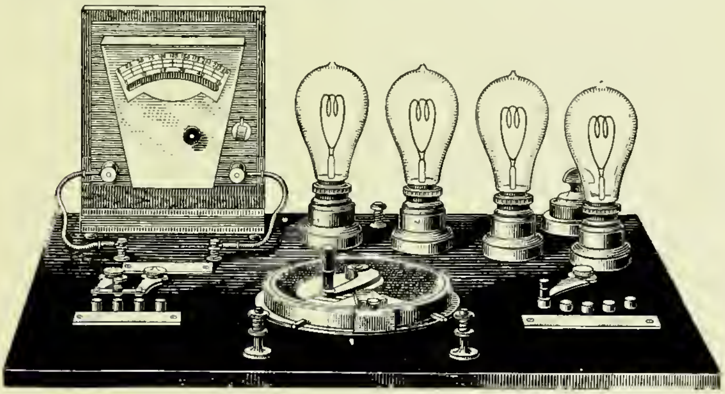

FIG. 2
Shunt Controlling-Apparatus

given an extended zinc surface on which it may act and neutralize the polarizing effects of the current.

When not in use, the liquid is more or less taken up by the absorbent material with which it is mixed, but as soon as the cell is put in action, the liquid is driven out from the interior of the carbon and serves to maintain the depolarizer around the external zinc in a moist condition. The cell is enclosed in an outer metallic casing insulated from the outer zinc cylinder by a bed of asphalt. Combinations of four cells in one box may give a current of up to 30 amperes at about 6 volts, while the smallest cell, of a size one-half of that of an ordinary dry cell, may deliver a current of 10 to 14 amperes at 1.4 to 1.5 volts.

11. Galvanism From Electric Street-Current. Fig. 2 illustrates a shunt controlling-apparatus adapted to the Edison 110-volt, direct street-current. It is a switchboard with four incandescent lamps in circuit, very light, in a box, and easily transportable. This device is designed exclusively to admit of the direct 110-volt current to be utilized for electrotherapeutic work, and is so arranged as to take the place of the more expensive resisting devices.

The system herewith arranged is well adapted to the Edison current, assuming that the physician has a rheostat and a milliammeter to utilize in conjunction with this device. It is also constructed upon a slate or marble base with a rheostat in series to modify to a minimum the various degrees of the current as required.

12. The *switchboard*, as illustrated by means of Fig. 3, is furnished by the Technical Supply Company, and is superior to any board in the market as regards efficiency, neatness, compactness, and good workmanship. It is made in the shape of a box, to enable the operator to carry it around, if necessary, from one part of a building to another, as, for instance, in a hospital, and makes it also possible to lock it up and thus prevent any handling by persons not familiar with its construction. The front is made of polished slate of high-insulating qualities, and all the various devices are fastened directly to this slate.

Behind the slate and directly supported by it is the faradic coil, likewise five dry cells for supplying the current for its primary coil, and also four resistance-coils that act as volt-selectors when the direct current from a commercial circuit is made use of. It is therefore seen that everything not absolutely necessary for the selection and variation of the current is put out of the way, and this makes it possible for the operator to handle the board with the least amount of confusion.

13. Perhaps the most important part of the board is the *ammeter*. If the use of the whole apparatus is to be satisfactory, it is absolutely necessary that the indications of the ammeter

be beyond doubt. The ammeters in most switchboards are of an inferior grade, and they are not alone unreliable as to their present indications, but the deterioration is such that their future indications may differ greatly from the present ones. For delicate electric doses, the ammeter cannot be too good, and

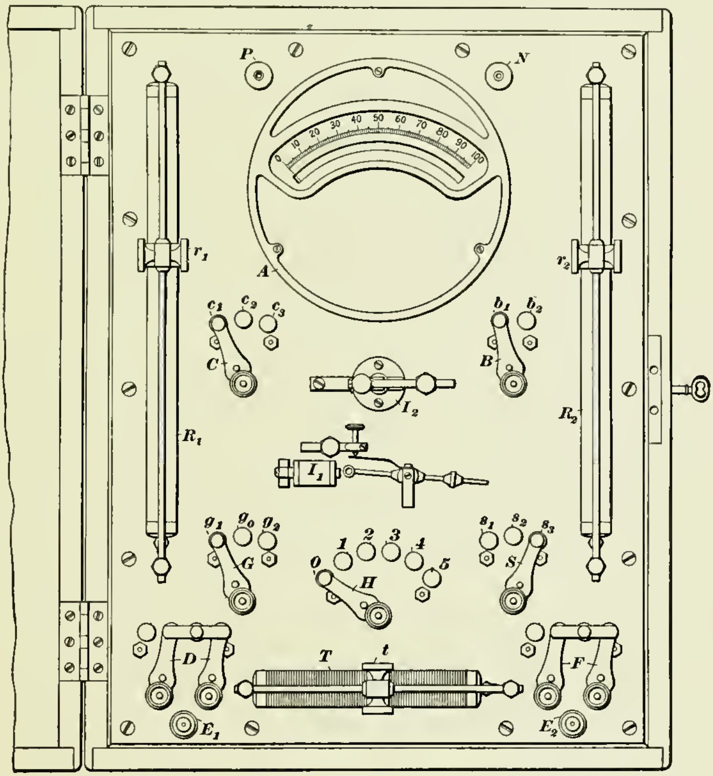

FIG. 3

Galvano-Faradic Switchboard

the board has therefore been provided with the well-known Weston ammeter, indicated in Fig. 3 by *A*. This is absolutely dead-beat, which makes it possible to make sudden variations in the current-strength without causing the pointer to fly violently all over the scale with the possibility of striking

the stops at the ends of same, and thus to cause an injury to the meter.

14. When it is desired to use the direct current of the commercial lighting circuit the conductors for the latter are connected to the two binding-posts *P* and *N*, *P* receiving the positive wire and *N* the negative. The switch *B* serves the purpose of making or breaking the connection between the lighting circuit and the various circuits of the board. In the position indicated, when the lever rests on the button b_1, the current is still cut off. To complete the connections, the lever must be moved to the right so as to rest on button b_2. The binding-posts E_1 and E_2 are to receive the conducting-cords of the electrodes with which the patient is to be treated. To bring these binding-posts in connection with the galvanic circuit the switch *D* must be moved to the left.

The board is supposed to be used with a 110-volt circuit. As this high voltage is inconvenient to handle, it is sent through four resistance-coils connected in series, each of about 200 ohms' resistance. Three of these coils are connected with the three buttons c_1, c_2, and c_3 of the volt-selector *C*. This makes it possible to supply an electric pressure to the binding-posts E_1 and E_2 of 30, 60, or 90 volts, when all resistance but the last coil is cut out, which coil always remains in circuit, leaving an extra resistance of 200 ohms between the patient and the 110-volt circuit. To reduce this pressure to zero, the sliding contact on the rheostat R_1 should be moved to its lowest position, and it should always occupy this position whenever it is desired to put the switch *B* on or off or increase the pressure by means of the volt-selector *C*. When, now, the slide r_1 is moved upwards, the pressure will increase up to 30 volts. Should this be insufficient, it is brought down to the zero position again and the volt-selector *C* moved to button c_2, giving 60 volts. By again raising the slide r_1, resistance is gradually cut out until 60 volts is supplied to the patient's circuit. If this is still insufficient, the procedure may be repeated and the selector *C* moved to the last button c_3, giving 90 volts. When once the suitable pressure has been found, the rheostat enables the

operator to make any desirable gradations in the current-strength to suit the requirements. The rheostats R_1 and R_2 are made of a column of slate, highly polished and covered with graphite, making them compact and neat in appearance.

The polarity of the two binding-posts E_1 and E_2 may be changed at any time by moving the pole-changer F either to the left or right. In its present position, E_1 is positive; by moving it to the left, E_2 will be positive.

15. When it is desired to use the faradic coil the switch B should be moved to button b_1, breaking the 110-volt circuit, and the switch D moved to the right. The current is now supplied by the dry cells connecting with the lever of the cell-selector H and buttons *1*, *2*, *3*, *4*, *5*. In the position indicated, the cells are out of circuit. On moving the lever to button *1*, one cell is connected with the primary coil of the faradic coil. The current-strength through the primary coil is regulated by means of the wire rheostat T, with the sliding contact t. There are two interrupters that may be connected with the primary coil. By moving the lever G to button g_1 the slow interrupter I_1 is switched in, and by placing the lever on button g_2 the rapid interrupter I_2 is put in action. When the lever G occupies the middle position over button g_0, both interrupters are put out of action.

16. The switch S regulates the length of the secondary coil, the buttons s_1, s_2, and s_3 connecting, respectively, with 300, 800, and 1,500 yards of No. 34 wire. If it is found that one cell is insufficient, the sliding contact t should be moved to the left, to include the whole of the resistance-coil T before the lever H is moved to any of the other buttons for the purpose of including more cells in the primary circuit.

In the faradic circuit the pole-changer F also serves the purpose of changing the polarity of the two binding-posts E_1 and E_2. The rheostats R_1 and R_2 are connected in shunt with their respective circuits, as this insures a more even regulation along the whole length of the rheostat instead of a small portion of same, as is mostly the case when a rheostat is in series with the main circuit.

17. Fig. 4 illustrates a wall-board devised by Dr. William J. Herdman, of the University of Michigan. This is a very excellent arrangement of apparatus for accomplishing all electrolytic work in genito-urinary surgery. For a description

FIG. 4
Herdman Universal Switchboard

of this wall-board, we refer the student to Plate XV, Art. **469,** *Electricity in Diseases of the Nervous System.*

HYDROGALVANISM

18. The instrument illustrated in Fig. 5 is designed for applying the direct current to the various parts of the genito-urinary tract without bringing the instrument in actual contact with the parts to be benefited thereby. The principle is that of an electric bath; the electrified water gravitates into the cavities,

which are thereby expanded, so that the whole surface of the cavities is more completely electrified than it could otherwise be and without the possibility of irritation that might arise from the use of the metal electrode, the instrument being only a vehicle for conveying the electrified fluid.

THEORY OF HYDROGALVANISM

19. By this means the urethra and bladder are submitted to the action of an electric douche, the stream of water conducting the electric current to all parts of the urethra and bladder.

The theory as a practical application is well expressed by Newman Lawrence: "All that is necessary, to insure that the

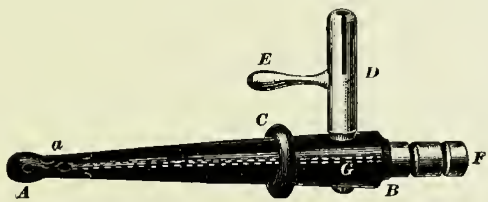

FIG. 5

Newman's Urethral Hydrogalvanic Instrument

A to B, Conical Hard-Rubber Tube. A, Small Holes for the Passage of the Fluid Into the Urethra. C, Movable Soft-Rubber Ring. D, Binding-Posts for the Attachment of One Cord of the Battery. E, Stop-Cock. B to F, Corrugated Metal Tube for the Attachment of the Rubber Tube for the Introduction of the Fluid. G, Platinum-Wire Lining the Hard-Rubber Tube for the Conduction of the Electricity

water or other fluïd is electrified when it reaches the patient, is to have the nozzle so constructed that the jet or jets of water form continuous streams for a reasonable distance after they leave the metal conductor within the nozzle."

20. Description of the Instrument.—The instrument is a conical tube of hard rubber, which can be inserted into the urethra from 1 to 2 inches, and has a soft-rubber ring attached that can be pushed against the meatus to prevent leakage. A stop-cock regulates the supply of the fluid, the top of which is used as one binding-post to attach the tip of one rheophore. The other end of the tube is used for the attachment of the

rubber tube for the introduction of the fluid. The tube is lined with a platinum wire for the conduction of the electricity.

21. Modus Operandi.—The fluid used may be a solution of sodium chlorid, or sodium bicarbonate, or any other medication, as the symptoms may indicate. As a reservoir for this fluid we use a glass cylinder, so as to ascertain by sight the quantity of the fluid used. The lowest part of this cylinder and the portion of the instrument *B F* are connected by a rubber tube, for the transmission of the fluid through the instrument. The glass reservoir is placed at such a height that the fluid will, by its own gravity, enter the parts to be electrified without any undue pressure.

For the indifferent pole, use either a pad placed on any part of the body or a sponge-electrode in the hand. The active pole of the battery is connected with the instrument at *D*. The end of the instrument at *A* is slightly lubricated and is introduced into the meatus so far that the conical part fills up the orifice.

22. The Newman instrument has been made conical in order that the meatus may be filled, as its caliber and that of the urethra differ in different people. When the conical tube has been inserted as far as is intended, a rubber ring *C* is pressed against the outside of the meatus, to prevent any leakage of the fluid. One hand only is needed to keep the instrument in place, while the other one is used to turn the stop-cock *E*, which allows and controls the afflux of the fluid to the parts, and also regulates the current-strength of the battery. The strength of the galvanic current should be from 5 to 20 milliamperes, according to effects desired.

The stop-cock should be so regulated as to keep the parts well filled with the electrified fluid, or even dilated so that it enters all the rugæ of the canal. If it is desired to change the electrified fluid, the instrument may be withdrawn slightly, to allow an escape of solution, and then the stop-cock may be turned on to give a fresh supply.

The average time for a séance will be about 10 minutes. Before finishing the treatment the current of the battery should be slowly reduced to zero.

23. The hydrogalvanic instrument may be used in tortuous urethral strictures of small caliber, in which it is difficult to pass a filiform guide—the urethra being very sensitive—in order to dilate, to lessen the tortuosity, allay the irritability, and heal up any sore or bleeding-point, and thus prepare the case for the regular electrolytic treatment. This, as a rule, is not necessary for the expert, but some operators may find the hydrogalvanism an aid in beginning the treatment, particularly when they find difficulty in introducing an electrode, or even a filiform guide

Hydrogalvanism has been conveniently used in these cases with marked benefit, and has cured several cases in which other methods only partly allayed the severe symptoms. If inflammation is present, the introduction of instruments is generally very painful, and often causes derangements of the bladder.

24. Diseases of the prostate consist mostly of inflammations and hypertrophies, and what has been said about inflammation of the seminal vesicles may also be applied to prostatitis.

"Obedient to surgical principles, no instrument may be introduced into the urethra while it is acutely inflamed The only exceptions thereto are when a foreign body requires removal or when retention demands relief by the catheter, after other means of voiding the bladder have failed."

In these cases of inflammation the hydrogalvanic application will, and undoubtedly does, produce sedation of these parts, and it will facilitate the after-treatment with other applications. It is a new field in prostatic diseases, and the probability is that it will cure some maladies of the prostate gland, supersede the former "do-nothing plan," and the present tendency toward cutting operations. So far, hydrogalvanism has allayed irritation, cured prostatitis, and some cases of impotence.

25. Urethritis.—The failure to abort *urethritis* has been due principally to the fact that the inflammation has caused such an irritable and painful state that it is impossible to introduce an instrument, syringe, or any medication. The important part is to make use of a certain stage in which the inflammation has assumed such a degree of irritability that the instrument under consideration can be used. This, or a

modification of it, can be used with more ease than any other instrument. Plain water may be used with a weak current of 5 milliamperes, and according to circumstances salt-water or even any other medication indicated. Electrolysis given by metallic electrode, or bulb, is apt to create more inflammation and possibly even a degree of cauterization. The hydro-electric galvanism is milder and better to abort the urethritis.

Chronic urethritis and all pathological discharges will be more safely treated by this method than by any other, because it dilates the caliber of the urethra and puts the mucous lining on a stretch, thus cleansing all parts alike.

26. The electric current is equally divided in every part of its course; the milder application of electricity will be better tolerated by the patient and the curative process takes place, which will not be accomplished by direct applications. Some may contend that by an introduction of an instrument of 2 inches the deeper portion of the urethra will not be electrified. By practical observation, however, it has been found that any part of the urethra can be electrified, and if the instrument be rightly handled, the fluid will penetrate to any depth of the organ. If any doubt arises, we have two means of making a "sure thing" still more certain. The first is to hang the reservoir containing the fluid higher, in order to increase the pressure from above—experience has shown that under such circumstances the fluid will even enter and fill the bladder. The other is to have the instrument made longer. It has been found from experience, however, that the latter is not always necessary, although sometimes of advantage.

27. Posterior Urethritis.—Celebrated specialists have been in the habit of treating such patients with injections of nitrate of silver, often so strong as to drive patients mad, and the disease has been made worse. It stands to reason that such severe measures are uncalled for and cannot cure, as the solution will diffuse itself alike over diseased as well as over normal tissue. A better treatment is the use of solid medications to the affected parts only, either by brush, ointment, or prostatic bougies. An urethroscope may be used in order to have an

ocular inspection, which will enable the operator to apply the remedies in situ to the affected parts only.

The passage of instruments over inflamed surfaces of the mucous lining is often too painful to be borne, and the patient will not endure the introduction of instruments or local medication. Such cases especially have been benefited by the application of the hydrogalvanization to such a degree that the patients considered themselves cured. In some of these cases the inflammation is so great that the disease will be carried into the bladder, and diseases of the bladder have been cured by hydrogalvanization by different means of application, and just as well in males as in females. A longer instrument, however, that can be introduced into the bladder, which has been filled with 4 to 6 ounces of either plain water or a medicated solution, is desirable. Then the catheter is placed inside the bladder in the water, which indirectly galvanizes the whole viscus.

28. Excoriations and Ulcerations.—*Excoriations* and *ulcerations*, and the latter especially, are very hard to cure in the urethra by ordinary means. Our hydrogalvanism will breach over the first part of the treatment in which the irritability of the parts prevents the direct application of electricity with solid electrodes. After a few séances with this method, direct treatment with electricity may be used.

29. Choice of Poles.—The operator must be guided in his choice of the pole of the battery to be used from the indications, and the pole selected according to the effect he wishes to produce. As a rule, the negative pole will be used, but in cataphoresis the positive pole is generally employed. In these cases the instrument is the active pole. The other, or indifferent, pole is either a pad placed on any part of the body or, as a sponge-electrode, held in the hand of the patient. The latter plan is preferred in most cases. However, if a more vigorous action is desired, the indifferent pole must be applied nearer the active pole.

30. The current to be used is from 5 to 20 milliamperes. We prefer weak currents, say 5 milliamperes, which has been

found sufficient in most cases, for stronger currents are apt to overstimulate and even cause inflammations and consequent discharges. The success depends on sound judgment, careful manipulation, and a perfect understanding of the instruments and the laws of electricity. The solution used in many cases is plain water, but salt-water or any other medication may be used as indicated.

31. Hydro-electric methods are nothing less than the electric bath localized to a certain part of the body, the current being transmitted either by pure or medicated water. The instrument devised by us is introduced to physicians for what it is worth and solely for the good it has done, and nothing more is claimed. Hydrogalvanism by this instrument will not replace the direct electric current applied through metallic electrodes. The hydrogalvanism in genito-urinary surgery wrongly applied by the tyro in electricity may do harm, but scientifically conducted it is useful, and in many cases paves the way for other treatment or other applications of electricity.

If the galvanic battery is omitted, the same apparatus is used for the irrigation of the urethra and bladder. For the urethra, it can be applied in urethritis and gleet. In diseases of the bladder, it acts as an irrigator, used for washing out and dilatation. In cystitis, hot water will allay the pain and spasm. The fluid enters the bladder by the siphon action and gravitation, without irritating the neck of the bladder or urethra. If the glass reservoir is lowered, the siphon's action will reverse the current and empty the bladder of any fluid. This apparatus is handy, portable, can be used in any place at a moment's notice, and for these reasons is superior to any other appliance arranged for a similar purpose.

32. Indifferent Electrode.—Long experience has taught us the advantages of a thorough understanding of the composition and location of electrodes. Among the electrotherapeutic appliances used by physicians, electrodes occupy a very important place. On the construction of electrodes depends the current-strength that a patient can tolerate and, therefore,

the therapeutic results that can be obtained. We desire to call your attention here to the indifferent electrode, particularly when that electrode is made positive.

As the negative pole is employed in the treatment of strictures, the positive pole becomes the so-called indifferent pole. The term "indifferent" applied to the inactive pole is unfortunate, as it has certainly contributed to render physicians negligent both as to the nature of the metallic base and the location of the electrode. The nature of the metallic base is not important when the indifferent electrode is negative. The conditions, however, are entirely changed when the negative pole is active and the positive is indifferent.

33. The composition and location of the indifferent electrode should be given every care. With regard to the composition of the electrode, two factors should be carefully studied, namely, (1) the nature of the metallic base of the electrode; and (2) the spongy material that should separate the metallic base from the skin.

As a protective between the metallic base of the electrode and the skin, about sixty layers of surgeon's gauze, as recommended by Dr. J. Bergonié, serve admirably. This gauze is always at hand; it is easily sterilized and always acceptable to the most fastidious patient. The number of layers and dimensions of the gauze will be determined by the current-strength employed. The nature of the metallic base is of the utmost importance and demands careful study. If, for example, the metallic base is copper and the surgeon's gauze is saturated with a sloution of sodium bicarbonate, on closing the circuit there is at once formed the oxid and carbonate of copper. These products of electrolysis are extremely bad conductors. A small piece of copper used as the base of an electrode offers 10 or 15 ohms resistance, but when covered with oxids and carbonates of copper, the resistance at once increases to thousands of ohms.

The best metal to use as the base of the electrode is platinum, but the price of this metal excludes its use. The next best metal is aluminum. This metal is cheap and it is extensively used in commerce today. Next to aluminum as a

metallic base comes block tin; then, nickel, copper, brass, and zinc.* We therefore recommend that either aluminum or block tin be used as the metallic base of the electrode when the positive pole is made indifferent, and that the protection between the metal and the skin be composed of sixty layers of surgeon's gauze. By using these metals as the base of the positive indifferent elcetrode, eschars may be prevented and the eurrent will be less painful on account of diminished voltage.

ELECTROCAUTERY AND ELECTRO-ILLUMINATION

34. The eurrent used for electrocautery, as wcll as for electro-illumination, may be either the direct or alternating. The eleetric current is not applied direct as a therapeutic measure, but used to heat a wire or light a lamp; it is only an aceessory means of diagnosis by means of light or treatment by means of cautery. Eleetrocautery is an improvement on former cautery measures, beeause the heat used ean be regulated and kept heated to the same degree.

For electrocautery we may usc: (1) plunge batteries, two elements and one acid, whieh are primary batteries; (2) secondary, or storage, batteries; (3) dynamos; (4) the street-eurrent by adaptors or controllers.

The prime object in using an electric current for cautery purposes is to generate heat, to keep the eautery-blade or cautery-loop at thc required degree of incandescence. We nced from 7 to 50 amperes of current for heating a burner or wire, according to the size and material of the burner employed. A rheostat to regulate the heat wanted and to maintain such is absolutely neeessary. One good battery with a rheostat to regulate the strength of the eurrent is sufficient for all kinds of work. An ammeter is sometimes necessary, as in the Bottini operation.

35. The galvanic battery that we have considered for the medieal and surgical applications cannot be used for eautery-work, as it will not heat sufficiently any burner of a good size. For eautery, the battery must be constructed for quantity;

*Dr. H. Bordier, "Archives D'Électricité Médicale," October, 1901.

therefore, it must have large plates and few elements with only a slight internal resistance. The external burner should be the point of highest resistance in the circuit, since it is here that the heat must be developed. Therefore, all parts composing the external circuit are made of large size, so that they may offer as little resistance as possible. These external parts are the connections, cords, handle, burner, or loop wire, écraseur, etc.

36. All primary batteries have the disadvantage of polarization; the heat first generated cannot be maintained and will grow less in time. In some operations, the same degree of heat must be maintained for 10 to 20 minutes and even longer. To prevent the polarization, the fluid in contact with the elements must be displaced constantly, so that the gases and other ions which may accumulate on the plates are washed off, and a new part of fluid comes in contact with the plates to replace the used and weakened fluid. This is done in several ways: either by moving the plates by rocking in a to-and-fro motion or by a kind of a scraper that operates like a pump running up and down, thereby scraping the elements clean and also replacing the fluids. All modern cells use chemical means to prevent polarization.

37. Dynamo circuits are often a convenient source of electric energy, and when the supply can be obtained from this source all the annoyances that may arise in the use of other means are avoided. However, the question arises whether this way is economical or safe, both being very important. (See Art. **40**, *Essential Apparatus.*) Adapters, or controllers, have been used with the street-current. There are many different varieties manufactured. While the street-current is very convenient for office use, there is always a question if it is safe to use and if the storage-battery is not the cheaper.

38. Advantages of Electrocautery.—Electrocautery has many superior advantages, among which we mention the following: (1) The avoidance of hemorrhage, primary or secondary. (2) Exemption from sepsis and its dangerous complications. (3) Its germicidal effects on deep-seated tissues far beyond the cauterized surface, as in cancerous infiltrations.

(4) The power of controlling and limiting its field of action in delicate and out-of-the-way cavities and parts. (5) Unlike other forms of actual cautery, it is free from the destructive effects of radiated heat on adjacent healthy structures. (6) It is the only means known by which a continuously heated wire may be made to surround and remove tumors or to destroy pyogenic membranes of fistulous canals.

ILLUMINATION

39. The *illumination* of cavities in the body, particularly for a satisfactory ocular inspection, has difficulties; in fact it has so many uncertainties that some operators have returned to the old methods of reflecting light, either sunlight or artificial, by a mirror. The difficulties to overcome are principally: (1) The accurate adjustment of the focus of the optical part, as any alteration in the distances, will disturb the clearness of vision. (2) The burner, which transmits the light, is another source of irritation, as a direct burner lights both ways and blinds the operator, and any transmission by reflection weakens the light at each angle.

40. Source of Light.—Storage-batteries are good, but are rather heavy for portable uses, and need great care to keep them in repair and well charged. Plunge-batteries polarize and thereby are uncertain in action. The best light is at the end of the tube at or near the cavity to be examined, if it can be protected sufficiently, so that the instruments used do not interfere with the burner. If small lamps needing only a low current of amperage are employed, dry cells may be used, which will make the apparatus more portable.

41. An Improved Cystoscope.—"A New Cystoscope for the Simultaneous Catheterization of Both Ureters, and for Double-Current Irrigation of the Bladder," by Frederic Bierhoff, M. D., New York City. This is an instrument designed to facilitate the catheterization of both ureters during the one sitting, and to leave them *à demeure*. It is a modification of the Nitze-Albarran single ureter-catheter cystoscope. The modification consists in the use of two separate tubes to convey the

ureter-catheters, and two knee-mechanisms, controlled by the same screw, to allow the curvature of the catheter, the whole being in one movable sheath, which surrounds the shaft of the cystoscope, Fig. 6. The method of use is as follows: A black

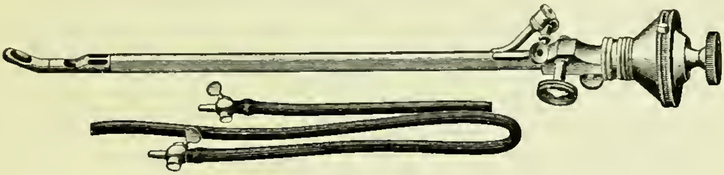

FIG. 6

A New Cystoscope for the Simultaneous Catheterization of Both Ureters, and for Double-Current Irrigation of the Bladder

ureter-catheter is inserted into the cannula on the operator's left hand and a brown one into the right. The instrument is then inserted in the same manner as the old cystoscope and one of the ureters sought for and catheterized (the catheter being inserted about 4 to 5 centimeters into the ureter). The

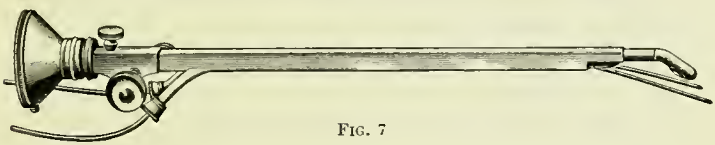

FIG. 7

knees are then turned down again and the other ureter located. During this latter procedure the first catheter moves out of the field of vision and may be entirely disregarded by the operator. The second ureter is now catheterized, the knees again turned down, and the instrument turned so that the operator may

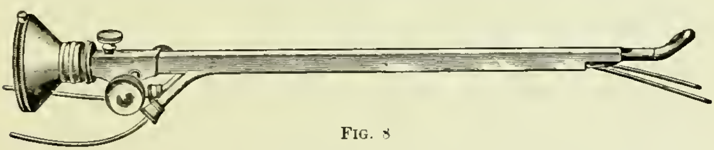

FIG. 8

assure himself before withdrawing it that both catheters are in situ (see Fig. 7). The lamp is then extinguished and allowed to cool, and the cystoscope turned upwards within the catheterizing portion, so that the beak points toward the middle line of the abdomen (Fig. 8), the catheterizing portion meanwhile

being held, and continuing to point, downwards. The instrument is then slowly withdrawn, its removal being compensated for by a gradual insertion of more of the catheters into the cannulæ. When the knees of the instrument and the catheters appear at the meatus, the catheters are held at the urethral orifice with one hand and the cystoscope steadily withdrawn with the other. In the course of the operation the black catheter will enter the left ureter, and the brown one will enter the right. It will then be an easy matter to collect the separate urines and distinguish that flowing from each kidney.

Should the fluid become turbid during the operation, the catheters and screw-caps on the cannulæ may be removed, the stop-cocks and rubber tubes inserted into the cannulæ, and the double-current irrigator employed before again refilling the

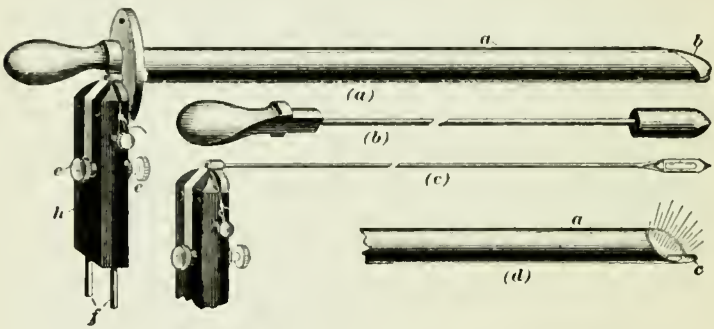

Fig. 9

bladder, the instrument remaining in situ. This instrument retains the size of the old single instrument of Nitze-Albarran (average 23 Charrière).

42. Other examinations for diagnostic purposes are made by exploring the bladder with a *bougie à boule*, or sound, and by injection or irrigations of the bladder, in order to find the capacity of the viscus, the state of the walls, its mucous linings, abnormal contractions, and the sensibility of the patient.

The systematic handling of the cystoscope to gain a concise knowledge of the topography of the bladder can only be acquired by extensive practice. Obstructions to the view may

occur, mostly by blood or pus covering the mirror, but an improvement has been made to wash away such impediments with a stream of water. The cystoscope requires a current of 7 volts in order to have a good light.

43. The Urethroscope, or Endoscope.—The *urethroscope*, or *endoscope*, for examining and treating the urethra and even the prostate, is perhaps the most important instrument in electric lighting. Fig. 9 illustrates an improved form of the urethroscope. For a description of this urethroscope, see Art. 40, *Physics of Light and Cautery.*

FARADIC CURRENT

44. The *faradic current* is a designation used in electrotherapeutics for the alternating induced current of comparatively high electromotive force, such as is given by an induction-coil or a magneto-generator. There are primary and secondary (induced) currents. The secondary is an alternating current, one that goes in opposite directions at each make and break of the circuit, which makes it impossible to measure the electromotive force with meters described before and used to measure the constant current.

45. The *physiological action* of this current is particularly stimulating and tonic, general and local. It is a stimulus to the contractile tissues, both directly and through their motor nerves, partly by its sensory nerves, and in a reflex manner through the vasomotor system, producing increased vascular activity in the parts it reaches. This current is also used as an alternative, by producing an excitation of the motor and sensory nerves, acting quickly on the cutaneous nerves, and exciting reflex action. There are uses of this current in genito-urinary diseases, particularly as a general tonic and controlling the spasmodic actions of certain organs. Constant improvements of the instruments in great variety will make the employment of it more frequent. The high-tension current has been much improved and is now often used with good effects.

SINUSOIDAL CURRENT

46. D'Arsonval introduced the *sinusoidal current* into electrotherapeutics in 1893. The apparatus from which the sinusoidal current is derived is growing steadily in favor. The simplicity of this apparatus and the ease with which it is manipulated account in some measure for its growing popularity. The real cause, however, for its widespread use is its wonderful influence over the symptom pain and its capacity to modify the nutritive processes of animal life. The sinusoidal current has a direct action on the nervous system of vegetative life—on the great sympathetic, independent of its action on the neuromuscular system.

With low frequencies applied to motor points, the sinusoidal current produces energetic, undulating, painless contractions.

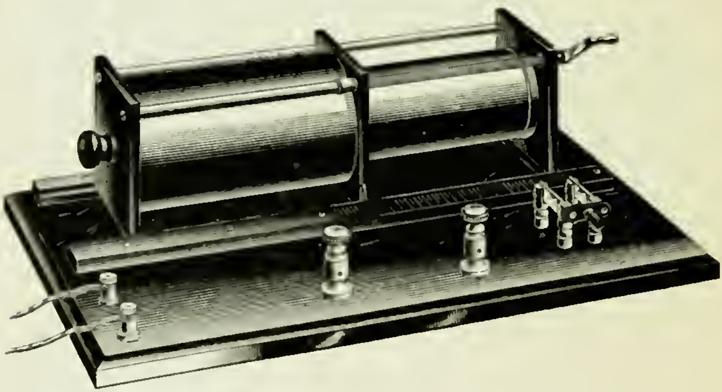

FIG. 10
Sinusoidal Apparatus for Alternating Current

With high frequencies, tetanic contraction is produced, which lacks, however, the cramp-like sensation caused by the galvanic and faradic currents. Both as an excitant and sedative to contractile tissues, sinusoidal currents have a wide range of use.

47. Method of Application.—The electric bath is a very satisfactory means of administering the sinusoidal current. For a description of this bath and its accessory apparatus, see *Physiology of Alternating Currents and Hydro-Electric Methods.*

A healthy individual placed in a bath through which a

sinusoidal current is passing will first observe a mild general tetanization of all the muscles of the body. A general sensation of being lifted from the water is experienced. This action of the current is followed by increased respiratory capacity, the absorption of oxygen by the blood-corpuscles being increased

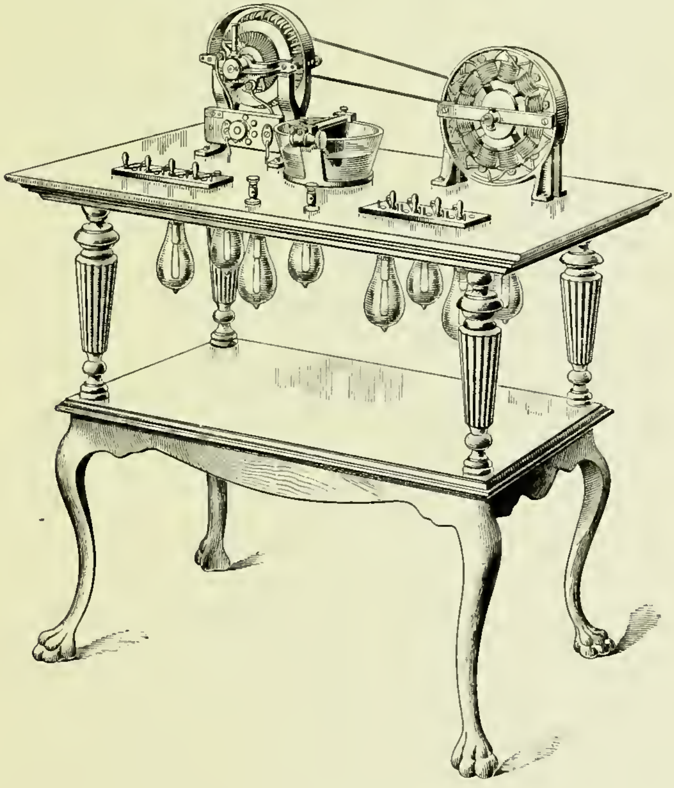

FIG. 11

Kennelly Sinusoidal Apparatus

20 per cent. In chronic congestion of the different organs of the body, a marked diminution of their size is observed after a course of sinusoidal baths. The importance of this action in cardiac and hepatic conditions is obvious. The secretion of urine is also considerably increased. The current serves to stimulate the muscles of the peripheral capillaries, which are

paretic from distension. This energy imparted to the peripheral circulation gives new vigor and tone to the central organ of circulation.

The genito-urinary surgeon will find in this current a reliable therapeutic agent in various pathological conditions that are very common in his routine practice.

48. Sinusoidal Apparatus.—For physicians who have the alternating current in their office, a very efficient sinusoidal apparatus has been arranged in the following manner by Gautier et Larat: The current is taken directly from a 110-volt

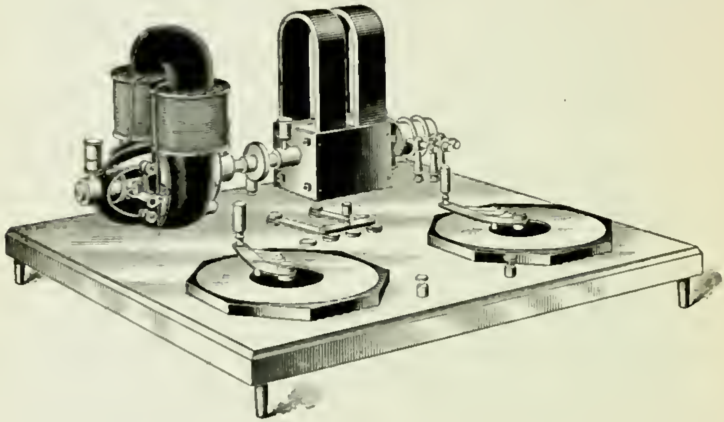

Fig. 12
McIntosh Sinusoidal Apparatus

alternating current with a 30-candlepower lamp interposed as a resistance. The current is then conducted directly from the lamp to the primary of an induction-coil. The current used in the bath is taken from a secondary coil constructed on the Dubois-Reymond type, Fig. 10. In this arrangement the frequency of the street-current cannot be changed. The current-strength is regulated by the degree in which the secondary coil overlaps the primary. The Kennelly sinusoidal apparatus is very convenient and serviceable, Fig. 11. For its use the 110-volt direct current is required. Another sinusoidal apparatus now in very general use is manufactured by the McIntosh Battery and Optical Company, Fig. 12.

49. The general bath, as a means of administering the sinusoidal current, necessitates disrobing. This is somewhat inconvenient and requires some time. A very efficient and convenient substitute for the general bath is the bath with four electrodes, as illustrated in Fig. 13. The patient is placed in a chair, the seat of which may be adjusted to suit the size of the patient. There are four separate cells, one for each of the arms

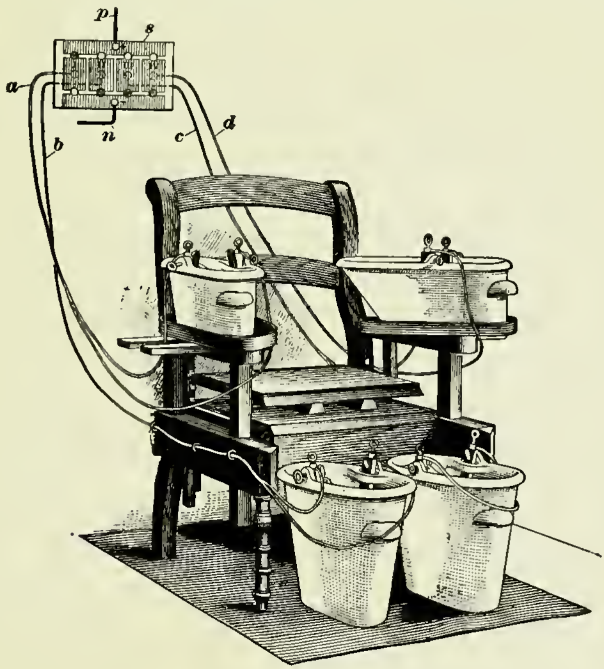

FIG. 13

The Four-Celled Electric Bath by Doctor Schnée

and legs, each having two electrodes. The conductors *a*, *b*, *c*, *d* from each of the cells are connected to separate plates *I*, *II*, *III*, *IV* on the switchboard *S*, shown enlarged in Fig. 15. Each of these plates may be connected either with the positive strip *A* or the negative strip *B*, the first being connected with the positive conductor *p* and the latter with the negative conductor *n*. For the purpose of making these connections, the switchboard

is provided with the holes a_1, b_1, c_1, d_1 and a_2, b_2, c_3, d_3 into which any of the plugs P_1, P_2, P_3, P_4 may be inserted. As shown in

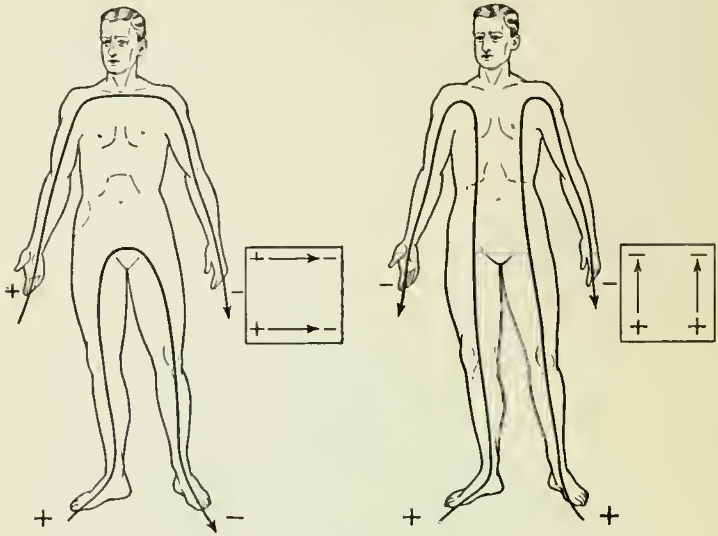

FIG. 14

the illustrations, the plug P_1 connects the plate *I* with the positive strip *A* and plugs P_2, P_3, P_4 connect the plates *II*, *III*, *IV* with the negative strip *B*. These four plugs may be rearranged to suit any requirement. Fig. 14 shows the direction taken by the current, according to the disposition of the current-terminals. The electrodes used in applying the faradic current serve also in the therapeutic uses of sinusoidal currents. Enclose a bipolar vaginal electrode in the palm of the hand, and, with the sinusoidal current of high frequency, observe the effects produced as the current-strength

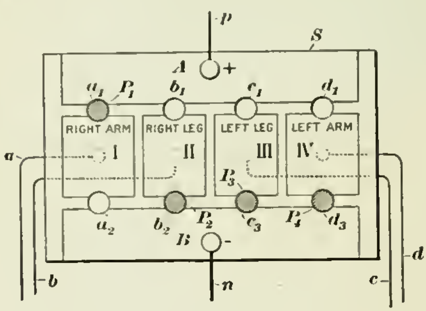

FIG. 15
Switchboard

increases to the point of toleration. This experiment will suggest many therapeutic uses of the sinusoidal current in the painful and congested conditions of the genito-urinary tract.

STATIC CURRENTS

50. "The year's fashionable drugs come and fade like a line of specters, but the electrostatic machine stays with us."* The history of electrotherapeutics of the static machine may be divided into two periods: (1) the period of the spark, from 1734 to 1880; (2) the period of the spark and spark-gap currents, from 1880 to the present date. The spark-gap currents are now generally known as *Morton currents*, having been originated and described by him in a series of articles appearing at various dates and in different journals from 1880 to the present time.

A striking fact that we have verified by extended observation is that when a physician has once acquired a working knowledge of a good static machine he continues to use that machine year after year with increasing benefit to his patients and constant satisfaction to himself. The thought of discarding it or procuring a substitute for it never occurs to him. He uses it with a feeling of certainty born of observation and experience, and he awaits the results of its action in the same security as he does those of quinin in malaria or mercury in lues. For information on this subject, we refer our students to *Technique and Physiology of Static Currents.*

The efficiency of a static machine will depend a great deal on the attention devoted to it. It does not require much care, but what it does require must not be neglected. A few minutes daily, a general overhauling once a year, with attention every month or two to the chemical in the case, will keep a static machine in first-class order and always ready to generate a current.

51. Doctor Snow uses the wave-current, particularly in two diseases, as follows:

"Impotency, or sexual neurasthenia, on account of its

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*W. J. Morton, M. D., New York Medical Record, December 9, 1899.

association with hypochondria, is favorably influenced by the psychical effects of the wave-current. The local vibratory action of a strong current applied in the rectum may often be felt to the end of the penis. This administration should be continued for at least 20 minutes and may be followed by application of sparks to the perineum and friction sparks to the penis if the case demands it. The tonic nutritional effects of the treatment is certainly one of which the physician can conscientiously make much to the patient and either cure him by suggestion or the physical effect of the current, or both.

"In the treatment of prostatitis, acute or chronic, the idea of suggestive therapeutics fails, but the results of the wave-current administrations in these cases is triumphant indeed. The application should be made by electrode about 5 inches in length and $\frac{3}{4}$ inch in diameter, being concave on the anterior surface to conform to the convexity of the prostate gland. The length will be sufficient to reach the seminal vesicles and include them in the administration.

"The spark-gap in these cases should be regulated as in all painful and inflammatory conditions—gradually increased as tolerance permits. The tolerance of the current in this region should allow the use of a spark-gap of from 6 to 12 inches before the close of each administration.

"The effects on the local condition are to promptly relieve all symptoms of congestion, pressure, and irritation. As a rule, these cases of neurasthenia need no other treatment, and are relieved of the nervous condition immediately on the institution of treatment. The impotence arising from sexual neurasthenia, in which there is lowered cellular vibrations for which strychnin and like remedies are prescribed, is greatly benefited by the administration of heavy sparks down the spine, and particularly in the region of the center controlling these organs. This treatment should also be supplemented by sparks applied to the muscular system, generally for its beneficial effects in metabolic processes and for its invigorating effects on the nervous system generally. It is a fact that heavy sparks applied over any of the organs have the power to modify the function of the organ."

STRICTURES

52. All *strictures*, no matter in what part of the body they occur, are obstructions or a narrowing of the caliber of the part caused by pathological formations of new tissue-elements. These pathological conditions may be within the caliber or outside surrounding it. Such formations take up a certain space and encroach on the walls, pressing from the circumference, thereby diminishing the caliber, or lumen, of the part affected. These structures are generally of a fibroid nature; but they may also be plastic bands passing from one wall to the other. Surgeons use different means in the treatment of this obstruction, which in many—we may say in most—cases do not cure the patient, because the new pathological formation is not removed. We depend entirely on the absorption of this pathological formation by electrolysis for a sure cure.

The chemical action of electrolysis causing the absorption of proliferated cell-elements is based on well-known principles of electrophysics, and its action is similar in all cases. But this action is so little known by the medical profession and is of such paramount importance that a chapter giving in detail the action of electrolysis is inserted here that the student may become familiar with this important subject.

ELECTROLYSIS

53. Definition.—*Electrolysis* is the decomposition of a compound body in solution by an electric current—a chemical decomposition. The body to be decomposed must be a conductor and possess certain elements to be an electrolyte, and as a compound body, must contain water and a salt. Acting in conjunction with this chemical action of electrolysis is that of *cataphoresis*, which by some authors is considered an important factor in electrolysis. The explanation lies in the direction of the current, between the elements from zinc to carbon, of the galvanic battery, or the current from electronegative to electropositive. In the external current, between the anode and the cathode, the direction of the current is directly opposite, and

the particles of the fluid gather at the electronegative pole, which is the cathode.

54. The action of cataphoresis is explained minutely by the following facts: The electrode connected with the positive pole of the battery is called the *anode*, and the one with the negative pole is called the *cathode.* The decomposition of the electrolyte is the splitting up of its molecules into their elements or atoms, which are called *ions;* hence, *anions* appear at the positive, and *cations* at the negative, pole. The ions may be single atoms of an element or molecules. Nicholson and Carlisle discovered this process of electrical decomposition in the year 1800, and electrolyzed water into oxygen and hydrogen; therefore, the theory is not new, and can be found in any textbook on elementary physics and chemistry.

55. Pure water is not decomposed by the weak currents used in electrotherapeutics, but this difficulty is readily overcome by

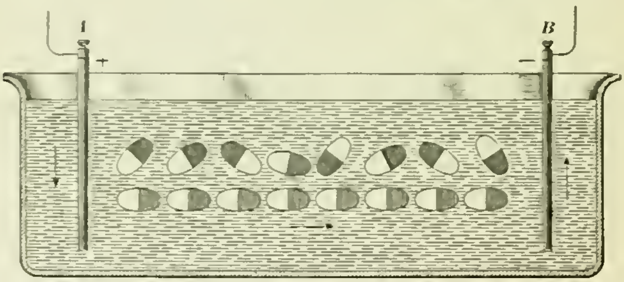

FIG. 16
Electrolysis of Water

adding to the water a salt, thereby making a compound, which is a better electrolyte, as it is more readily decomposed into its elements. Common table salt is used for this purpose, but the chlorin liberated in the decomposition tarnishes the positive electrode; hence, bicarbonate of soda is preferable, and a 5-per-cent. solution is about right. Fig. 16 will better explain the action of the electrolysis inside the battery and at its poles.

The molecules are arranged so that the oxygen is turned toward the positive electrode *A* in the upper line, while in the lower line the molecules are arranged in a chain across the liquid.

The atom of oxygen nearest the positive electrode is thus liberated as free gas, and the 2 atoms of hydrogen combine with the atom of oxygen directed to it in the next molecule and form a new molecule. This action extends throughout the chain, and, ultimately, the two atoms of hydrogen of the last molecule, having no further molecules to split up, are liberated as free oxygen gas at the negative pole *B*. It is clear, therefore, that the accumulation of the elements of the electrolytes so decomposed is at each respective pole, which is *polar*. From experiments made, it is certain that the principal action of electrolysis is at the poles. Hence, it is necessary to test the poles of the battery and see first that the galvanic battery is in perfect working order.

ACTION OF THE POLES

56. The action of the poles is very different in electrolysis; hence, each has its own function. The positive pole attracts the acids and the oxygen from the tissues, and coagulates blood. The negative pole attracts the alkalis and hydrogen, and coagulates albumen and causes absorption. Hence, the positive pole acts and burns like an acid, which is not only exceedingly painful, but may leave a hard, resilient cicatrix. On the other hand, the negative pole acts more like a caustic alkali, which does not hurt so severely during the application, and leaves, if carried to excess, a cicatrix that is soft and retractile. From this, it is evident that for the immediate destruction of tumors and for strictures the negative pole should be selected. Electrolysis requires the presence of water, and that you will find in every tissue in the human system.

As it is most important to distinguish the poles, and as we cannot trust to the marks of the instrument-maker, we must always ascertain which is the positive, and which the negative, pole.

TESTS FOR THE IDENTITY OF EACH POLE

57. We have five principal tests for the identity of each pole: (1) The water test; (2) the meat test; (3) the decomposition of a salt; (4) test by galvanoscope; and (5) by the polarity distinguisher.

1. *Water Test.*—The simplest and best method is the experiment that we make for testing the battery. Immerse two electrodes in the form of platinum needles in water, and you will see the hydrogen at the negative pole, which shows itself in distinct bubbles, like pearls, around and above the needle, sparkling almost like carbonic acid in an effervescence.

2. *Meat Test.*—The poles of the battery in the shape of two needles (platinum are best) are inserted in a piece of raw fresh meat. After the electrolytic action has been allowed to take place for awhile, the difference in pole-action can readily be observed. Even the application of 5 seconds shows an effect. Five milliamperes of current shows different decompositions in 5, 10, and 20 minutes. The positive pole has made the meat black around it—almost charred and destroyed it—while at the negative pole the color is different, being nearly white, and bubbles of the hydrogen also appear like a white froth. While electrolysis is in active operation a hissing sound is heard at the negative pole, and the positive is noiseless, blackens the meat, and litmus paper applied to it shows, by its red color, an acid reaction.

Another phenomenon is the tenacity of the positive needle to the piece of meat. The needle at this pole is firmly adherent to the meat and can be removed only by rising force, tearing away some of the production of electrolysis. This is very important for the operation, as the closure of blood-vessels will be reopened again by a forcible removal of the needle. The needle, or electrode, at the negative pole is so loose that it will drop out by gravity, *which is another proof of the absorbent action at the negative pole.*

A piece of fresh meat still contains water enough to be an electrolyte, while the living body in which the circulation is active, is better. A dried-up piece of meat is no electrolyte.

Practical Experiments.—We have made on pieces of meat and pathological specimens, particularly with carcinoma, the following experiments:

(*a*) Into a piece of raw fresh pork two large platinum needles were inserted, at a distance of 3 inches. The current from a galvanic battery of thirty-five cells was allowed to pass

for 15 minutes, after which time the meat between and around the needles was thoroughly changed into a soft pulp. A weaker current caused changes accordingly; the current of five cells produced distinct effects in 5 seconds, twenty cells in 1 second.

(*b*) Into a piece of meat containing a bone in its center, the needles were inserted at a distance of 2½ inches from each other. One large platinum needle was then connected with the positive pole, while two small steel needles were connected with the negative pole. These needles were inserted close to the bone, and one directly into the bone-cells. The galvanic current of thirty-five cells, in 15 minutes, produced changes in the entire tissues, so that even the bone around one negative needle was entirely destroyed. Moritz Meyer, of Berlin, has electrolyzed with perfect success the bony tumor of a boy's forearm, but needed for it 118 séances.

3. *Decomposition of a Salt.*—If, for instance, a solution of iodid of potassium be subjected to electrolysis, one equivalent of hydrate of potassium will be liberated at the negative pole,

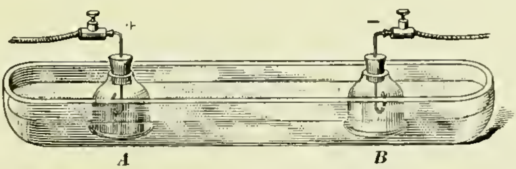

FIG. 17

Electrolysis of Solution of Potassium Iodid

showing that the potassium liberated from combination with the iodin has combined with some of the surrounding water. This can be illustrated by simply holding both poles in the solution while the galvanic battery is in action, or better in a **U**-shaped vessel.

This experiment, however, is more strikingly demonstrative and original when made in the following manner: Two small glass vials are filled with a solution of iodid of potassium. The bottoms of the vials are substituted by pieces of pig's bladder, the necks are then stopped by corks, through which platinum wires run, one end of each being immersed in the solution and,

the other attached to a pole of the galvanic battery. Both vials so closed are placed in a dish of water; they are 6 inches distant from each other. There is no communication between them except the water, and as long as the battery is at zero, no change takes place in the solution, which is transparent and undisturbed. A change, however, takes place as soon as the battery begins to act. Only six cells are in circuit, and almost immediately in the vial connected with the positive pole streaks of yellow appear, and in about 5 minutes the vial contains only a dark, yellow fluid, which is the iodin set free at this pole. At the negative pole the contents of the vial remains clear, only bubbles of froth welling up. This is the hydrogen set free from the water. The result of this electrolysis is iodin, oxygen, and hydriodic acid at the positive pole, while at the negative pole we find hydrogen and potassium. In order, therefore, to introduce iodin into the tissues from a solution of potassium iodid, it is first necessary to decompose the potassium solution by means of positive electrolysis, and then connect the decomposed solution to the negative pole, making the positive pole indifferent.

If this same experiment is tried with a faradic battery, no change whatever takes place in the solution. This is another proof that the action of the galvanic current is widely different from that of the faradic, and that for the electrolysis a galvanic current only can be used.

Any compound body or salt-solution can be similarly electrolyzed or decomposed, which may be illustrated as follows: In a solution of sulfate of copper the positive pole will attract sulfuric acid and oxygen; the negative, copper and hydrogen. In a chlorid-of-sodium solution, chlorin will go to the positive, and sodium to the negative, pole, etc.

4. *Test by Galvanoscope (or Milliammeter).*—If the two electrodes are brought in contact with each other, the needle will deflect toward the positive pole.

5. *Polarity distinguisher* is a simple and practical test. It is constructed on the Oersted principle, that the magnetic needle tends to assume a position at right angles to the direction of the electric current. This small instrument shows the positive pole

by the appearance of the red color in the fenestra as soon as the poles are held in contact with the instrument.

58. Non-conductors are chalk, fat, oil, rubber, dry gases, and a multiplicity of other substances. Success, therefore, depends on the organic quality, form, and composition of the neoplasm of the stricture. Blood and muscular tissues are good electrolytes; hence, strictures readily yield to the electrolytic treatment. Fibrous tissues are more or less decomposed by the current, and that in proportion to the elements which enter into their composition. If the parts to be acted on are devoid of water, the electrolytic action will be slow, because water or moisture is necessary and forms one of the real elements of successful decomposition. Chalk being a non-conductor, it follows that calcareous strictures, which are dry and brittle in their narrow caliber, will not yield well, if at all, to the action of the electrolysis.

Having become acquainted with the different properties of the poles, each of which possesses its own specific powers, it is evident, from the foregoing, that for the destruction of strictures, the negative pole must be selected.

59. The next important question that arises, and which is a valuable factor for successful treatment, is, What is the best material to be used on the negative pole? We should select hard metals, those that stand in no danger of being decomposed or easily oxidized; hence, platinum, gold, and silver are best, but lead, tin, or brass do well.

The specific action produced by electrolysis in the treatment of stricture has received different names. This diversified nomenclature has produced considerable misunderstanding, and time has done little to remove the confusion and obscurity in which the action of electrolysis is still involved. Dutrieux calls it electrochemical cauterization. Dittel names it a chemical galvanocaustic. It seems that all who have written and experimented on the subject mean the same thing, but express it differently. This diversity in the nomenclature has provoked the criticism of the editor of that special department in Virchow's "Yahresbericht." Dutrieux, he says, depends for

the action of electrolysis on the caustic effects of the negative pole, which leaves a soft and less retractile cicatrix, and wonders that Newman relies on chemical absorption as an effect of the electrolytic action.

That the same thing is meant, is evident from the previous statement, as well as from the description of the modus operandi by Mallez and Tripier, who lay great stress, and rely on the chemical and not on the caustic effect that would result from the application of the positive pole or the approximation of the two poles. With such a definition, which is taken from Mallez and Tripier, why the French surgeons call the action "*par la galvano-caustique chimique*" cannot be understood.

60. Next, the term *absorption* must be defined, as some may object to it as not definite enough, or understanding that it pertains only to the action of lacteals. Webster's definition of absorption is as follows: "The process or act of being made passively to disappear in some other substance through molecular or other invisible means, as the absorption of light, heat, electricity, etc.," and such is the action exactly, as we will see hereafter.

The negative pole acts as a caustic alkali. If increased tension is used, it will destroy tissue; but mildly applied, it acts as a chemical absorbent on the altered tissue and restores the part to its normal condition. No one would think of curing a stricture by cauterization. The history of that treatment in uterine diseases has left too many painful reminiscences. The gynecologists loudly protest against a treatment that has proved so mischievous and unfortunate in uterine diseases, and this applies equally well to attempts to follow it in cases of stricture of the urethra.

STRICTURES OF THE URETHRA

61. The positive statement is here made that these strictures will be radically cured by electrolysis, which removes the pathological tissue in every instance. As proof of this statement the following statistics are introduced. We have successfully used this method of electrolysis in the treatment of urethral strictures

in more than 2,000 cases, which is not a large number for 30 years' active service, and would average not more than five cases per month. Eight years ago we published a compilation of 1,755 successful cases in the practice of fifty-four different operators,* mentioning their names and favorable opinions of the said method. In the same number of the journal in which this was published appeared an editorial from which the following is quoted: "The statistics accumulated by Doctor Newman, if all were reported, would cover a list of over 2,000 cases of urethral stricture treated by the electric method. In the face of such a mass of positive evidence, one is tempted to explain the dissent existing by the application of the personal equation. Still, every one has the right of opinion and free expression; and if the opponents of this method desire it, the columns of the Times and Register are equally at their service." No statements of dissent have been sent; the writer gave documentary evidence for everything stated, which was investigated and found correct by an impartial committee of the American Electrotherapeutic Association, who reported accordingly. Many of these patients have been kept under observation, have been reexamined after years, and no relapse followed. Today, after an interval of 25 years, most of these can be found stating that they have kept well without having had a relapse. In a few instances a patient returned after years with a new ailment, mostly of the prostate or bladder, but never had a stricture in the same place, which had been cured by electrolysis. During these years we have never lost a patient by death while under treatment for a stricture.

Death, however, followed in every instance known to us when a patient gave up the electrolytic treatment by us for the sake of undergoing a urethrotomy, which in these cases was never performed by us, but by most skilful surgeons of unquestionable ability, who did the work well. The operators cannot be blamed for the fatal result, but we must accuse the system. The causes of death in these cases were mostly sepsis and uremia, after a secondary hemorrhage. Cystitis and suppression of

* Times and Register, April 3, 1893.

urine had preceded. Nowadays the strongest advocates of urethrotomy will not promise a cure, and patients so operated on will remain patients until the end of their lives. Any incision either heals by first intention, which makes the caliber of the same size as before the operation, or if the divided surfaces are kept apart a cicatrix by granulation is the consequence, which is worse than it was before the cutting. It is useless to give the details of these cases, which were received only by courtesy of the operating surgeon, and only refer to cases known to us. Other methods may cure certain strictures that are simply contractions within the urethra, but it has not been proved that fibrous pathological conditions of induration, invading tissues around and outside the urethra, and even the cavernous and spongy bodies can be removed by cutting, divulsion, or dilatation.

62. Definition of Urethral Stricture.—Writers have described different kinds of stricture, and all have spoken of a spasmodic stricture, which we consider a most unfortunate mistake. "*Where there is failure to pass a sound through the urethra, it can only indicate either unskilful manipulation, organic stricture, or a tortuous urethra from prostatic enlargement.*"* A spasm is a temporary action, dependent on other causes, and should not be called a stricture, besides the successful treatment must be different. For our purpose we can acknowledge only an organic stricture, which is a permanent stricture dependent on pathological conditions. Therefore, the definition of an organic stricture should be a permanent narrowing of the caliber of the normal urethra, which either exists in the urethra itself or in the tissues surrounding the canal. In most cases, pathological formations of fibroid plastic material accumulate, grow, and, by taking a space for themselves, crowd against the canal, thereby diminishing its caliber. Sometimes we find these submucous infiltrations in all parts of the penis, except in the cutaneous covering; they may cause a very long stricture or in different parts of the urethra appear as multiple strictures.

* R. W. Stewart, M. D., M. R. C. S, "The Diseases of the Male Urethra."

Complications may add violent spasm to an organic stricture, and then need a different treatment for either. Such strictures always begin with a thickening of the mucous lining of the urethra, which is the first stage of the disease.

63. Etiology.—The cause is almost always an inflammation. This may occur from any obstruction—traumatism—but as a rule it results from the long continued discharge, the consequence of a chronic urethritis. During the course of an urethritis, stricture may be caused by too strong injections, the use of instruments, or even catheterization. However, all strictures are the consequence of an inflammation.

64. Symptomatology.—As a rule there is a general malaise, a gleety discharge, frequent micturition, uneasiness, hesitation, delay, pain, and scalding on voiding urine, the stream of urine is getting smaller by degrees, later on it has less force, and may only dribble away. The prostate gland may become involved; also a vesical catarrh causing an alkaline urine, which gets cloudy, and by degrees becomes loaded with phosphates, ropy mucous, pus, and blood. The consequences in time are more dangerous, the bladder dilates, gets paralyzed, stagnant urine accumulates, fills the ureters, affects the kidneys, and finally the retention of urine may end fatally.

65. Diagnosis.—Patients go to the physician not for the treatment of the stricture, but because they are troubled with unpleasant symptoms that should cause the doctor to suspect the disease. The diagnosis, however, can only be made correctly by a careful examination with good instruments. The differential diagnosis is nevertheless important, and the following maladies have particularly to be considered and excluded: granular urethritis, chancroids, syphilis, gouty concretions, spasm, prostatitis, vesical catarrh, neuralgia, calculus, tumors, abscesses, hemorrhoids, fissures, and other rectal diseases. A small stream, for instance, does not always indicate a stricture, particularly if it appears suddenly and is temporary. Twenty-five per cent. of cases that have been sent to us by good practitioners for treatment as strictures proved, on examination, to

be other diseases, which seems to show that the diagnosis is not as easy as may appear.

66. History.—The history of the operation of urethral stricture by electrolysis is brief. Several attempts were made as early as 1847; other operators have followed in Germany and France with imperfect instruments, and often the wrong pole was applied, patients thereby not being benefited. A graphic description of the wrong method has been made by a celebrated surgeon, who stated that he himself used the positive pole at the stricture with so strong a current that he destroyed it in one sitting by *cauterization*. No wonder that he did not cure his patient and condemned the electrolysis. French operators of the old method called it a *galvano-caustique*, which also proves that they intended to cauterize with strong electric currents. Such mistakes are, in part, the reasons why some make objections to a method they do not understand. We have practiced this method since 1866 and improved the instruments during the succeeding years. The electrodes to be described here were devised by us about 1870. Literature of the subject has increased and many successful cases have been reported by operators here and in Europe, and many enthusiastic converts have been made.

PHYSIOLOGICAL EFFECT OF ELECTROLYSIS ON MUCOUS MEMBRANES

67. The contact of the positive pole with the mucous lining by a metal-bulb electrode causes great pain. The electrolysis thus applied feels and acts similarly to a strong vegetable acid, destroys tissue, and is not easily borne. But if the negative pole is used with the same electrode, no pain follows the application, provided the current is not too strong; it thus produces a sensation of pricking and burning.

If a limited electrolytic power be selected and applied by the usual method, the current is gradual and slow in its action, and we observe the following: (1) The mucous lining of the urethra is often covered with an alkaline secretion. The electrolytic action coagulates it in a semisolid mass. The same

result may be observed if the albumen of an egg be submitted to the action of both poles. (2) In the absence of this secretion, moisture only being present, a general stimulation takes place. (3) Agitation. (4) Lifting and loosening of epithelium. (5) Attraction and disintegration. (6) Coagulation of alkalis. (7) The epithelium shrivels. (8) The epithelium is detached and lost. (9) Mucous lining dries and gradually changes color from a pinkish red to white. (10) The caustic action begins to take effect and causes slow absorption. Tissue is absorbed and disappears. (11) The metallic extremity of the bougie insinuates itself in the deeper tissue, producing a depression. (12) The electrolytic action having made a passage, the albuminous secretions on the walls of the urethra are acted on by the negative pole, coagulating it, and bearing resemblance to boiling froth.

Electrolysis may become caustic in its action if too strong currents are used, destroying tissue and leaving a denuded surface behind, which in the healing process throws out plastic lymph, fills up the cavity, and forms solid and adherent walls. If powerful electrolysis is used, it rapidly opens a passage; the perforation thus made forms a scab on the wall of the urethra. To illustrate this physiological effect and at the same time the power of the battery used, a few experiments made on dogs may illustrate.

Experiment 1.—A good-sized dog was placed under chloroform, merely for the purpose of operating and observing without being interrupted by the animal's struggles. The application was made on the external mucous lining of the penis, which was pushed forwards in front of the sheath. To the positive pole of a 40-cell galvanic battery was attached a forceps, with which the lower portion of the penis, where the prostatic portion is situated, was firmly held. This prevented the penis from slipping back, and the effect of the positive pole could be observed. The negative pole connected with the wire was a silver bougie, egg-shaped, the size corresponding to No. 0 wire gage. The circuit was completed by bringing the bougie, as the negative pole, in contact with different parts of the penis. Distinct effects were produced in the following

time: Five cells produced distinct effects in 5 seconds; ten cells, in 2 seconds; twenty cells, in 1 second.

When all forty cells were used, a boiling commenced immediately, smoke arose, a hissing sound was heard, a froth was formed around the point of the bougie, and a hole was produced in a short time. The effect produced by the two poles differed widely, and could be observed as follows: The positive pole had caused a destruction of parts in an uneven, ragged manner; the surface looked like an ugly sore of a yellow color, mixed with gray at the margin. It stimulated somewhat the ulceration of a chancroid. At the negative pole was seen only points, small in circumference, of a whitish color; even a little of the pinkish hue was left, and there was no destruction of tissue. A smooth surface was presented, but the normal lubricating moisture had given way to a dry state. This dryness at the negative pole, and the destruction of tissue with an ulcerating surface at the positive pole, gave rise to a partial phymosis afterward.

Experiment 2.—A dog was prepared as in the first experiment. The positive pole, by means of a forceps, firmly held the mucous lining of the penis far back, where the prostate lies. A bougie, of an egg-shaped form, connected with the negative pole was introduced into the urethra, 2½ inches deep. Then the electrolysis was used with all forty cells at once, and continued for 20 seconds. A boiling was distinctly seen and heard around the negative pole; at the positive pole a destruction of tissues and an ugly sore was produced exactly as in the first experiment. The dog felt sick, had no appetite, and could not urinate for 2 days. The malaise was increased by the sore and the addition of the destruction at the positive pole, again caused an inflammation and phymosis. After 2 days the obstacle in the urethra gave way at once, the plug formed by the electrolysis popped out, the dog passed water mixed with blood, and it finally made a good recovery.

Many other experiments have been made, and all prove the correctness of the theory explained before. The last experiment was only made to ascertain the tolerance of a strong current as a therapeutical agent. This experience has proved

conclusively that the means of curing strictures consists mainly in using weak currents. Mischief may be done by strong currents, which destroy tissue rapidly instead of causing chemical decomposition.

EXAMINATION OF STRICTURES

68. When the narrowed caliber of the urethra first attracts the attention of the patient, the physician must at the first examination decide if the cause of it depends on an inflammation of the mucous lining or on the new plastic formations around the urethra. In the first instance, the caliber of the urethra is narrowed by the product of inflammation thrown out by exudation internal to the mucous lining. The case may be complicated by the presence of more or less granulations, whereas in the latter case the caliber is lost by the pressure on the altered parts and heteroplasia of the deeper submucous tissues. The knowledge of this pathological condition is a fact of much value for the intelligent and successful application of electrolysis; if this is understood, it necessarily follows that both the current-strength and the duration of its application should be increased in order to penetrate the tissues to produce absorption. Certain facts should be inquired into concerning the history of the case, such as the general condition of the patient, former diseases, inherited diatheses, peculiar dyscrasia, complications, etc. Having ascertained this history, and noted carefully all its details, the investigation is still further continued by direct examination of the stricture in the following manner: (1) By instruments and digital transmission; (2) by exact measurement; (3) by ocular inspection.

69. Examination by Instruments and Digital Transmission.—The exploring instruments transmit to the fingers certain sensations, which experience soon classifies, and which culminate in a highly tactile expertness. The best instrument for this preliminary exploration is the whalebone bougie à boule, which has a small olive-shaped bulb and a slender neck that adds to its flexibility without losing a certain stiffness. Such an exploring instrument gives, from its peculiar shape, a delicacy of touch not to be obtained

from any other known instrument. It defines with professional certainty the nature of the stricture, and the progress of altered tissue can be ascertained and defined with a comparatively small experience, and with great certainty.

According to the sensation transmitted to the fingers, the progress of the stricture can be ascertained and four stages recognized as follows: The first stage conveys a feeling of velvet or velveteen; the second, paper; the third, parchment; and the fourth, cartilage. In the normal state of the urethra, the bougie glides with comparative ease over its moist mucous lining. The skilled finger will readily detect any alteration or deviation; its comparative and relative severity and the slightest encroachment on its normal standard will be revealed. The velvet touch represents a slight alteration only; the paper touch represents the inflammatory stage; the parchment touch represents fibrous tissue; the cartilage touch represents calcareous, or callous, deposit, and signifies the worst form of stricture.

By the use of the olive-shaped whalebone bougie, the defects or any abnormal condition of the urethra along its whole tract is soon detected. The instant the bougie enters the stricture, a peculiar feeling is manifest to the fingers of the operator; its penetration is announced with a great degree of certainty; there is a peculiar grasp—"a taking hold"—which is distinctly felt on entering or withdrawing the bougie.

70. Examination by Measurement.—In order to ascertain with certainty the exact locality, lengths, size, etc. of the stricture, we introduce into the urethra a sound as large as the meatus will admit. By this maneuver we ascertain at the beginning of our manipulation the normal caliber of the urethra. The sound is then pushed gently forward until we reach the stricture. That being accomplished, we carefully note, in inches, by actual measurement, the distance of the first stricture from the meatus. Next, we ascertain how large a sound the stricture will allow to pass; at the same time an attempt is made to ascertain the length of the stricture. Having discovered the available sound, the exploration is continued until the whole of the stricture has come under notice. If any more

strictures are discovered during the investigation, they are measured in the same manner as the first. A note of this topography is made and carefully recorded, because in all future operations the perfect knowledge of the localities of the impediments is of extreme importance for their proper treatment.

The measurement of a stricture can also be made with a urethrometer. Newman's urethrometer is curved and can be introduced into the bladder. Another instrument for measurement is the urethrograph, invented by Dr. R. W. Stewart, which gives an exact drawing of the urethral canal on paper like the sphygmograph.

71. Examination by Ocular Inspection. — Ocular inspection by the urethroscope will reveal important facts, such as form and color, character, or any complication by which the case may be surrounded. The form of stricture is not of necessity always annular; the contraction may vary and assume many different forms. Thus, there may be irregular slits of different sizes, and in all directions, oval, round, square, triangular, and serrated — in fact of infinite variety.

A fact of vast importance, and an extremely valuable factor in the diagnosis, is the following: When the tube of the endoscope is withdrawn from the urethra after an exploration, if the stricture is sensibly indurated and especially if it be a slight one, the canal closes immediately behind it with great abruptness, a circumstance which is in striking contrast with the gradual closing observed on the withdrawal of the instrument from a healthy urethra. After a careful and minute examination is made and the state, size, etc. of the urethra duly noted, a plan of action and future treatment in accordance with the principles previously enunciated is concluded on and immediately carried out. In manipulations in the urethra or bladder, all surgical precautions, it is needless to say, should be scrupulously observed.

DIFFERENCE OF METHODS

72. There is a marked difference in the methods practiced with regard to the battery used, their elements, the fluids, the correct electrodes, the pole as the working electrode, the strength

of the current, and the duration and the interval of the séances. Then the intended effect as a system has to be considered, whether an electrolytic or a cautery action is wanted, or a combination of the two. From experiments made, observations of other operators, and a large personal experience, we have come to a conclusion, and therefore recommend only one procedure, as follows: Electrolytic action, by mild currents, from batteries with small cells containing weak fluid. This current produces gradual chemical absorption when properly constructed electrodes are skilfully manipulated, as will be described hereafter.

73. The Armamentarium.—This consists of a good galvanic battery, with conducting-cords, one or two handle electrodes as the indifferent pole, a few binding-screws, one milliamperemeter and rheostat, a bougie à boule, filiform guides, and four sets of Newman's urethral electrodes. These instruments suffice for our treatment, and the sound electrodes may be procured by installments as required. As auxiliary instruments, may be mentioned an urethrometer and an urethroscope.

74. The Galvanic Battery.—This must be selected for the production of mild electrolysis. A battery presenting a large surface and big cells is unsuitable, as it will cauterize more rapidly and more intensely than a caustic. By using a superabundance of electric current, induced by a large surface, with the hope of augmenting its sphere of action, too much inflammation is induced, destruction of the surrounding tissues takes place, suppuration supervenes, and the disease is thus aggravated. The current should never be strong enough in its action to lead to destruction of tissue; it should be confined to an effort to restore the affected parts to their normal condition.

In its application, the current of proper strength should be confined solely to the diseased locality. This is not always easy to accomplish with the batteries at command, and some failures on record may be mainly due to their defects; one of the most important is the want of thoroughly controlling the strength of the electric current. In the selection of the battery, the following points are important: (1) The tension of the

current must be augmented gradually cell by cell, without any interruption or shaking of the current, and the patient will hardly perceive the increase of tension that can be used. (2) The quantity of electricity must be reduced to a point sufficient to produce the most intense action on a very limited surface. (3) The cells must be small and the surface of the elements in proportion to the cells in order to absorb only and not to destroy tissues or cauterize. (4) Shocks, interruptions, and pain to the patient must be avoided. The fluid used must not be too strong,

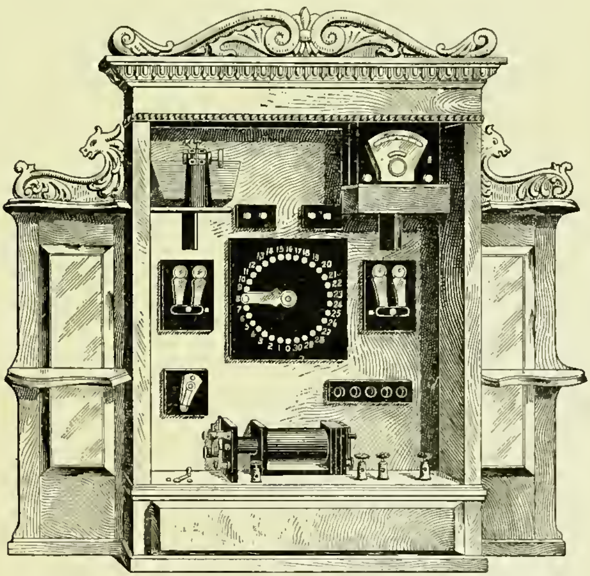

FIG. 18
Wall-Cabinet

but more diluted than ordinarily used. Any good instrument that has the described qualities can be used as a portable battery. We have constructed a 20-cell battery, which has already been described. In the office, a *cabinet*, Fig. 18, is very serviceable. We have cells in the basement and the dial in the office as a wall-cabinet. The latter has a pin for each of the forty-four cells, a current-changer, an interrupter, and the upper part is an ohmmeter. Below the interrupter are the binding-posts

for the two poles. On the left side are the switches; the one on the left is for the constant current, the second is for the interrupter, and the third connects the galvanic current with the milliammeter, which is placed on the top of the cabinet, and the scale of the milliammeter is read by reflection of a mirror. There is an independent set of cells with extra binding for other purposes.

75. Bougie à Boule. — This is the best exploring instrument that transmits to the finger certain sensations, which experience soon classifies, and which culminate in a highly tactile expertness. This instrument, Fig. 19, is made of whale-

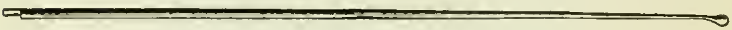

FIG. 19
Bougie à Boule

bone, has a small olive-shaped head and slender neck, which adds to its flexibility. It is used to explore the urethra and find the number, nature, and size of strictures—the real topography.

76. Filiform guides are used to prevent false passages, over which the tunneled electrodes run with perfect safety.

FIG. 20
Filiform Guide

When the passage is very small and tortuous, the filiform, Fig. 20, by its flexibility, will adapt itself to the urethra and can be introduced into the bladder. This instrument must be managed with care, so that it does not turn on itself; it must be without a blemish or bend; the end must be perfect and not split, avoiding the danger of the electrode running into the divided parts and thereby being arrested. Any spasm of the neck of the bladder may prevent the entrance of the filiform into that viscus.

ELECTRODES

77. Electrodes are the most important feature for the treatment of urethral strictures. After many trials and experiments the following conclusion has been reached: Sounds (electrodes)

for the correct exploration of the urethra must be either entirely flexible, or stiff and unyielding. To the first class belong Nclaton's and Jaqucs's, which adapt themselves to the curves and inequalitics of the urethra. These may answer for certain cases, but are not applicable for electrolysis as a rule. The type of the second class of explorers is the steel sound. The operator has it in his power to guide the sound where he pleases; it will not diverge from the course it is directed in; it is firm, never yielding. If the sound makes a false passage, the operator is held and made rcsponsible. It is best to have a short curve for the guidance of the operator's hand. The old fashioned large curves were mistakes, and did mischief.

The surface of the electrodes must be smooth and well insulated, and without any inequalities. The only points not insulated and acting as conductors are the terminals, to one of which the conducting-cord from the battery is attached. The other terminal is acorn-shaped, or olive-shaped, for passage through the strictured urethra. A conical end is objectionable and would spoil the operation. For instance, if the instrument is a No. 10 and its conical end tapered equal to a No. 7, the electrolysis naturally cannot enlarge the stricture to a caliber larger than No. 7. When the conical end has passed and is free, the thicker part of the instrument hangs grasped by the constricted part of the urethra and cannot follow into the place nor push its extremity; or, in other words, the No. 10 cannot occupy a space of size of No. 7. As the only factor of reliance in this treatment is the electric power of absorption and not force, it is evident that the egg-shaped bulb answers best.

The length of this bulb extremity is in proportion to the size of the instrument; for a No. 11 French scale, the end is $\frac{3}{16}$ inch, for a No. 21 French, $\frac{3}{8}$ inch, etc. We have devised four different electrodes, which are known as *Newman's electrodes.*

NEWMAN'S ELECTRODES

78. Egg-Shaped Electrode.—The regular electrodes for all ordinary cases have a short curve and an egg-shaped, Fig. 21, metallic bulb at the working end, while at the other end there is

a round wire rod for the binding-screw of the negative pole of the battery. These are the only parts not insulated. The rest of the electrode must be well insulated, smooth, and without inequalities. A conical bulb is objectionable in most cases, as we depend on the electrolytic power of absorption, not on

FIG. 21

Egg-Shaped Electrode

force. The set consists of Nos. 11, 14, 17, 18, 20, 21, 23, 25, 28 of the French scale.

79. The Acorn Set.—These are for use in the first 6 inches of the urethra in certain cases, and consist of Nos. 15, 17, 20, 22, 25, 27, French. They are without a curve, short, and the bulb is acorn-shaped, Fig. 22. Sometimes it is desirable to gain ground by entering the contraction first with the point of the electrode, in order to follow easier with the larger part of the acorn; here, this form will do good work. The action of the electrolysis depends on the largest diameter of the bulb in these cases, and does most service on the withdrawal of the electrode, when the operator feels best how much work should be done. It is also used when the stricture is near the meatus.

FIG. 22

Acorn-Shaped Electrode

80. The Tunneled Electrode.—These are in Nos. 9, 11, 14, 17, 20, 21, French. They are very important for bad, tortuous strictures, and are to be used only by the expert operator. The curve is shorter and the egg-shaped bulb tunneled, so that it may be introduced over a filiform guide, Fig. 23. When the strictures are tortuous, these electrodes are safer, and false passages are impossible.

81. The Combination Electrode.—This is a tunneled electrode combined with a catheter, Fig. 24. When a very tight stricture is complicated with retention of urine, the indications are to remove the obstruction and draw off the urine with the same instrument, as the parts are too sensitive to tolerate the

FIG. 23
Tunneled Electrode

introduction of two instruments in succession. The patient may also be benefited by washing out the bladder, all of which can be done with one introduction of this instrument, in which case some small quantity of water must be left in the bladder.

82. The bulbs of all the electrodes are just as large as the size they represent, not conical at the end as are the sounds usually sold. This makes a difference of from six to eight numbers between Newman electrodes and the shop instrument in which the number is expressed by the size at the shaft. The length of all electrodes is 8 inches from the bulb to the handle,

FIG. 24
Combination Electrode

and in almost all cases the bulb will be in the bladder after the instrument has been passed to the handle.

83. Difference in Sizes Between Newman's Electrodes and Sounds.—Attention may be called here to the apparent difference of the sizes between Newman's electrodes and usual sounds as sold by instrument-makers. The diagrams here presented are made from measurements of instruments in actual use.

Fig. 25 (*a*) and (*b*) represents the ordinary steel sounds, which are conical at the end, and the number is expressed by the size of the largest part of the stem, making a real difference of from six to eight numbers in different parts of the instrument. Fig. 25 (*c*) and (*d*) represents Newman's electrodes,

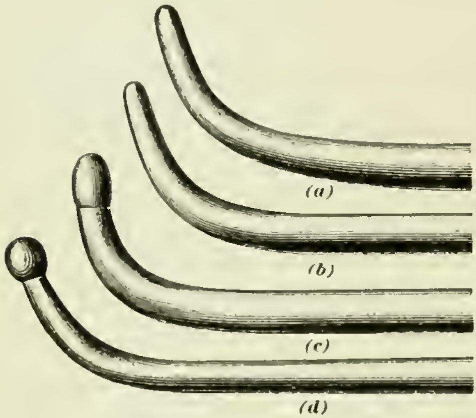

Fig. 25

which have their full size at the bulb end, as numbered. It will be seen at a glance that in the steel sounds a No. 38 is, at its conical end, only a No. 29, this tapering end making a difference of four and nine numbers, respectively. Therefore, the No. 32—French scale—Newman's electrode is as large at its end as the No. 46 steel sound. Hence, the diversity of opinion referred to is, in a great measure, explained by these diagrams, especially in relation to the result of treatment by electrolysis.

MODUS OPERANDI

84. The object is to produce the solvent action of the alkalis and the disintegrating effects of diffused hydrogen. The art of applying electrolysis successfully consists in: (1) using the correct strength of the electric current; (2) applying the respective poles in the right place; (3) selecting the size, shape, and material of the electrode; (4) regulating the duration and intervals of séances; (5) avoiding any hemorrhage by adjusting the current and careful manipulations.

85. Electrolysis applied with a mild current will cause absorption only — a galvanic chemical absorption — while a strong current will burn, cauterize, or even destroy tissues.

Therefore, the operator must know what effect he wishes to produce, and graduate the strength of his current accordingly. The management of the operation must be such that every possible mishap is anticipated and prevented.

The diagnosis having been made, the stricture examined and measured with the bougie à boule (as previously explained), the history taken, the topography of the urethra well ascertained, and a plan made for the treatment and operation, a full knowledge is attained of what is intended to be accomplished. It is not advisable to operate on the same day; it is better to have one day intervene between the preliminary examination and the operation. Genito-urinary surgery is generally applied too severely, and often causes new inflammation instead of allaying it. It is also well to try the patient's susceptibility to the galvanic current, and assure him that he has nothing to fear from a weak current of a galvanic battery, as most people are not familiar with other effects than shocks. Much is gained if the patient comes to the operation fresh in mind and body, without any nervous depression.

86. The posture that the patient should assume during the operation is a matter of slight importance; according to his convenience he may stand, sit, or lie on his back with his shoulders elevated and his knees drawn up. Anesthetics are not used, for no pain should be caused, and the patient should be conscious, so that he can express his sensations. In exceptional cases of great nervous irritability, an injection of cocain —a 2- or 4-per-cent. solution—or any anodyne, may be used. It is still better to have the patient himself insert a rectal suppository 1 hour before the operation. Such a suppository may be composed of extract of belladonna, $\frac{1}{4}$ to $\frac{1}{2}$ grain; aqueous extract of opium, 1 grain, with a vehicle of gelatin or cocoa-butter. These anodynes are only for irritable, nervous patients, otherwise they are not necessary, as the operation should not cause any pain. All preparations must have been made before operating. The galvanic battery must have been previously tested in all its connections, so as to ascertain without a doubt that the poles have been marked correctly by the

manufacturer. The negative metal electrode must be warmed and lubricated with glycerin, and the other end connected by a binding-screw with the cord of the negative pole of the battery. The milliammeter must be well connected between the battery and the patient with modern appliances. It is of the greatest importance to fulfil all these details deliberately, carefully, and with scrupulous minuteness, in order to secure success. Antiseptic precaution must be observed particularly with the instruments to be employed.

87. For ordinary strictures the rule is to select an electrode that is three numbers larger than the size of the stricture, French scale. For very resilient strictures, it may be necessary to take an electrode one or two numbers larger. However, there are exceptions, which are governed by indications. When all preliminary arrangements have been made, the electrode is selected, lubricated with glycerin, which is a conductor, and then introduced into the urethra until the bulb is arrested by the stricture. It is also well if a mark has been made on the stem of the electrode, to indicate the distance of the stricture from the meatus, thereby making certain when the bulb end has reached the beginning of the stricture according to the measurements previously made. The positive electrode, wet with either hot water or salt-water, and connected with the positive pole of the battery, is to be held firmly against the patient's skin, either in the palm of the hand, the abdomen, the thigh, or some other part, to complete the circuit. At this stage of the procedure, it is well to observe that the positive pole touches only the cuticle of the patient, and not any metal. Rings or other jewelry will burn and must not come in contact with the circuit. While both poles are held in this manner, the current should be increased from zero until the patient feels a warm and slightly pricking sensation. This increase is made slowly, one cell at a time. At the same time the current is measured by the milliammeter, and in many cases 3 or 4 milliamperes will suffice.

The operator must keep the bougie steady against the stricture, and he will soon find that absorption is taking place,

that the stricture yields, enlarges, and the instrument slowly advances and passes the obstruction. At times it will fairly jump through the stricture. If there are more strictures than one, the bougie should be guided in the same way until it enters the bladder. Then the electrode is to be withdrawn slowly, stopping at each stricture, until the electrolysis has enlarged the caliber of the urethra sufficiently for an easy passing of the electrode used, which has to be guided and withdrawn, until the first stricture has been repassed, when the current is again to be reduced slowly, cell by cell, to zero; and then and not until then is the electrode to be removed. During the whole operation the electrode must be held loosely and gently in its place against the obstruction, any pressure or force being avoided. The bougie will take care of itself, doing its work by the electrolytic action of the current. It is best to guide the electrode with only the thumb and first finger; sometimes the second finger may be added. All the fingers of the whole hand should never be used. Gentleness must be exercised to the greatest degree, as the use of any force will prevent the action of the electrolysis and only act as any ordinary dilatation. A séance may last from 5 to 20 minutes, and if the electrode has not passed the stricture in that time, it is often better to discontinue than to unduly tax the patient or cause an irritation. The operator must now see that the battery is disconnected and the electrode well cleansed.

88. Each pin in the circle of the dial of the battery represents one cell, and the selector must be placed exactly on the pin and not on two pins, which would make a short-circuit of these two cells, or may make the galvanic current unsteady. No oil should be used for lubricating the electrode, as all oils are *non-conductors.* The use of vaseline is also dangerous, as it may enter the bladder, cake, and become the nucleus for a vesical calculus

The operator, experienced in this kind of manipulation, is always made aware, by digital transmission, of the location of his electrode and the nature of the pathological tissue when he comes in contact with a stricture. The current should never be allowed to become so strong that it causes pain. Pain

is a sign that either the parts are in an inflammatory condition or that the current is too strong, and may cauterize instead of absorb. As a rule, on withdrawing the bougie electrode, there will be around the tip a frothy, white mass, which bears a resemblance to coagulated albumen. This is the hydrogen freed from the decomposed tissues, and if this mass has yellow streaks intermingled with it, it may be a part of the stricture.

At each operation only one instrument should be introduced into the urethra, and never two or more. After the operation, the patient must be left unmolested, no instrument used, and no sound, or catheter, introduced. Any instrumental interference will do harm and spoil the success.

SÉANCES

89. An interval of one week must be allowed before a repetition of the operation can be made, and even a longer time if indicated by pain or other symptoms. At each following séance a larger electrode is used, generally two numbers larger. Such treatment must be continued until the urethra has recovered and resumed its normal caliber, whatever this may be. As a rule, every patient may be well content, if his urethra admits a sound of No. 24 French. Generally, the treatment must be continued until the urethra has the normal caliber, unless circumstances contraindicate the attempt.

AFTER-EFFECTS

90. After-effects, like urethral fever, cystitis, etc., do not take place, but will follow if any instrumentation, like catheterization, is attempted after the electrolysis. This is another advantage of the electrolytic treatment over all others, and even Doctor Bumstead admits this in his excellent work, saying: "Either of the modes of treatment (of strictures) now described may be followed by rigors and other unpleasant symptoms, which are known as urethral fever, and sometimes terminate in speedy death."*

* Bumstead, "Venereal Diseases," page 300.

91. The question is often asked, Is the result of the treatment an absorption or a dilatation? *Never—no dilatation!* It is a mistake to say that the action of electrolysis is a dilatation, or, as some author remarked, a modified dilatation. It is no dilatation at all, because the electrode is passed by simply holding and guiding it through the stricture. This is done by absorption and thereby causes an enlargement and restitution of the caliber. The absorption of the fibrous tissues goes on gradually, relieving the stricture and enlarging the caliber of the urethra until it is restored to its normal size.

We protest against electrolysis causing any dilatation, which is an entirely different process, in which some kind of force is always more or less necessary, and force in the electrolytic application is always a fault. Opponents sometimes say, "Perhaps it was a spasmodic stricture!" We assert positively that spasmodic action must be treated by the faradic current, and that galvanism makes the spasm worse. If galvanism cures a stricture, it is a proof that it was an organic stricture.

CURES AND RELAPSES

92. Reports of success have been in abundance—patients have been cured by electrolysis and have never had relapses and remained well. Some patients have been under observations for over 26 years without having had a day of sickness or any relapse. Have autopsies proved the absorption? Yes, they have. Many years ago Dr. C. C. Terry presented a specimen to the New York Pathological Society, which proved that electrolysis had restored the mucous lining of the urethra to a normal state. Our experience is that autopsies have confirmed his ante-mortem conclusions.

Statistics of successes of the electrolysis with no relapse have been reported in abundance, mostly verified by documentary evidence. Investigations of the reports of our statistics have been made. The final report in the "Transactions of the American Electrotherapeutic Association for 1893," page 40, was verbatim: "We have examined the records of Doctor Newman's cases and regard his conclusions as well sustained by the statistics, and as far as our experience in this line of work adds

further testimony, it is confirmatory of the value of the continuous currents in resolving a large class of urethral strictures, etc." This report is signed by Doctors A. H. Goelet, Wm. J. Morton, and W. J. Herdman. That under some circumstances some medical critics throw doubt on the correctness of the statistics, appears almost as a wilful libel.

RULES

93. The following rules, as a recapitulation, are a safe guide for the treatment of urethral strictures by electrolysis:

1. A good galvanic battery must be used, either portable or cabinet, having certain qualities for electrolysis.
2. The fluid for the battery should not be used too strong.
3. Auxiliary instruments are good to the expert, but not so necessary for the beginner. However, a milliammeter is imperative.
4. A carbon electrode is used for the positive pole. It must be covered with felt or absorbent cotton, moistened with hot water, and held firmly against the cutaneous surface of the patient's hand, thigh, or abdomen.
5. The negative pole must be used for the absorption of the stricture.
6. Electrode bougies are firm sounds insulated with a hard-baked mass of rubber; the point is an egg-shaped metal bulb, which is the acting part in contact with the stricture.
7. The curve of the bougie is short; large curves are mistakes.
8. The plates must be immersed in the fluid before the electrodes are placed on the patient, and raised again after the electrodes have been removed.
9. All operations must begin and end while the battery is at zero, increasing and decreasing the current slowly and gradually, one cell at a time, thus avoiding any shock to the patient.
10. Before operating, the susceptibility of the patient to the electric current should be ascertained.
11. The problem is to absorb the stricture, not to cauterize, burn, or destroy tissues.
12. Weak currents at long intervals.

13. In most cases a current from $2\frac{1}{2}$ to 5 milliamperes will do the work, but it must be regulated according to the work to be done.

14. The séances should be at intervals of one week, not oftener.

15. The best position for the patient to assume during the operation is that which is most comfortable for himself and the operator. We prefer the erect posture, but the recumbent or others may be taken.

16. Anesthetics should be avoided.

17. Force should never be used. The bougie must be guided in the most gentle way, and the electric current alone must be allowed to do the work.

18. Two electrodes in succession should never be used during one séance.

19. All strictures are amenable to treatment by electrolysis.

20. Pain should never be inflicted by this operation. Therefore, it should not be done when the urethra is in an acute or even subacute inflammatory condition.

21. The electrode should not be greased with substances that are non-conductors and would insulate.

22. For ordinary stricture, the size of the electrode selected should be three numbers (French) larger than the stricture.

ADVANTAGES OF ELECTROLYSIS

94. The advantages of electrolysis are as follows: (1) Electrolysis is applicable to all strictures in any part of the urethra. (2) It will pass and enlarge any stricture when other instruments or the skill of surgeons fail, which has often been demonstrated. (3) It causes no pain or inconvenience. (4) It is devoid of danger. (5) It is not followed by hemorrhage, fever, or other unpleasant consequence. (6) It relieves at once. (7) The patient is not prevented from attending his daily work or business, and can earn his living while under treatment without restraint. (8) No relapse takes place, if once cured.

STATISTICS, SUMMARY

TABLE SHOWING REPORT OF CASES FROM 201 TO 300 OF OUR 300 CASES

Number	Patient's Initials, Residence, Date of First Visit	Age—Years	Cause, Duration, Complications of Stricture	No. of Strictures Found	Distance from Meatus, Inches	Size of Stricture, Fr. Scale No.	Treatment: How Many Séances	Treatment: Average Intervals, Days	Treatment: Time of	Sequel and Caliber of Urethra when Discharged, French Scale No.	Last Heard From After Treatment	Time After Discharge Without Relapse
201	M. G. F., N. Y. C., 1887, March 23	49	Continued urethritis, 7 yr.; impotence	4	2, 4, 5, 6	12	15	10	5 mo.	Urethra enlarged to No. 28	March 27, 1890	3 yr.
202	E. G. B., Albany, 1887, March 26	55	Strictures, 20 yr.; prostate enlarged	3	2½, 4½, 6½	18	8	14	4 mo.	Urethra enlarged to No. 82	March 30, 1892	5 yr.
203	J. W. R., Oregon, 1887, March 31	35	Urethritis, 15 yr.; spinal irritation	3	3, 4½, 6½	11	4	5	4 wk.	Improved to No. 23; left for home	March, 1888	1 yr.
201	E. S. E., N. Y., 1887, May	32	Urethritis, 3 yr.; bungling electrolysis; periurethral abscess	3	2, 4, 6	6	7	8	2 mo.	Improved to No. 17; very little progress. Withdrawn.	*	
205	C. C. W., Chicago, 1887, June 9	48	Urethritis, 8 yr.; character unknown	3	5, 6, 7	18	2	3	†	In two séances, enlarged to No. 23	June, 1890; through family physician	3 yr.
206	S. H. H., N. Y. C., 1887, July	29	Prolonged urethritis, 2 yr.; Urethrotomy	2	3, 5½	18	20	8	5 mo.	Urethra enlarged to No. 32, Fr.	Reexamined Jan. 8, 1889; well	2 yr.
207	W. G. C., Ulster Co., 1887, July 27	23	Strong injection, 3 yr.	4	4, 5, 6, 7	0	15	12	6 mo.	Urethra enlarged to No. 26, Fr., the limit of meatus	Heard from him and family physician; is well	4 yr.
208	W. M. H., St Louis, 1887, Aug. 19	32	Long continued urethritis, gleet, 4 yr.	2	3, 4	17	7	9	2 mo.	Caliber enlarged to No. 28, Fr.	Reexamined with No. 28, Sept. 1888; well	1 yr.
209	G. R. B., N. Y. C., 1887, Aug. 24	40	Gleet, 3 yr.	3	3, 4, 6½	15	8	8	2 mo.	Enlarged to 26, limit of meatus. Well	June, 1892, well; no relapse	5 yr.
210	R. S S, New Haven, 1887, Aug. 29	24	Prolonged urethritis, 1 yr.	3	3, 5, 6	17	6	14	3 mo.	Enlarged to 28. Normal caliber 26. Well	Reexamined Sept. 5, 1888	1 yr.
211	M. H. M., New Haven, 1887, Aug. 29	23	Urethritis, gleet, 2 yr.	2	5, 7	18	4	12	6 wk.	Enlarged to No. 25, Fr., size of meatus. Married and well	Reexamined Oct. 16, 1888; well	1 yr.

* Former injudicious electric treatment has injured the case. † Operated while in Chicago.

212	E. S. G., Tennessee, 1887, March 27	42	Prolonged urethritis, 10 yr.; prostatitis, cystitis	2	3, 5	23	8	10	3 mo.	No. 27 Fr. Well	Reexamined Aug. 11, 1891; well	5 yr.
213	W. D. C., N. Y. C., 1-87, Oct. 2	53	Inflammation, traumatism. bladder overdistended, 5 yr.	2	5, 7	4	5	12	2 mo.	Improved; 14; gone west	Oct. 23. 1889; written that he felt great relief	2 yr.
214	J. C., New Orleans, 1887, Oct. 5	27	Strong injection; urethrotomy, 2 yr.	1	7	0	10	8	$2\frac{1}{2}$ mo.	Enlarged to 26; gone to N. Orleans; well	Not heard from.	
215	J. M. D., Indianapolis, 1887, Oct. 19	60	Not known; enlarged prostate, 4 yr.	1	5	20	3	4	2 wk.	Improved to 26; content and gone home	Not heard from.	
216	D. T. H., Newark, 1886, Aug. 1	50	Balanitis: cicatrix after porotomy, 3 mo.	1	Meatus	18	5	7	1 mo.	No. 27; well	Reexamined Feb., 1892; well	6 yr.
217	H. T., Brooklyn, 1887, Oct. 30	22	Strong injection, druggist's mistake; traumatism, 6 mo.	3	2, 4, 6	8	25	10	9 mo.	No. 21; improved; temporary; failure	Relapse, 1890	Failure.
218	T. B., Charleston, 1887, Nov. 15	24	Urethritis; urethrotomy, 6 yr.	2	6, 7	20	4	7	1 mo.	No. 28; well	Physician reports well, 1892	5 yr.
219	R. W. G., Bloomfield, N. J., 1888, Jan. 80	46	Strumous inflammation; ulcers, 2 yr.	1	4	7	5	6	1 mo.	Improved, 20; Dr. Wile continued treatment	Dr. Wile reports patient well, 1892	4 yr.
220	I. T. K., Blairsville, Pa., 1887, Nov. 16	37	Prolonged urethritis; orchitis, 11 yr.	1	4	17	6	7	$1\frac{1}{2}$ mo.	Enlarged to 28: well	Not heard from.	
221	C. D. B., N. Y. C., 1887, Nov. 23	47	Gleet, 20 yr.	2	5, $6\frac{1}{2}$	12	7	8	2 mo.	Enlarged to 28; well	Not heard from.	
222	A. L. B., N. Y. C., 1887, Nov. 28	50	Traumatic rupture of urethra, 17 yr.	3	$2\frac{1}{2}$, $5\frac{1}{2}$, $6\frac{1}{2}$	20 16	7	*	3 mo.	Enlarged to 28; well	Reexamined twice, Nov. 1888	1 yr.
223	J. B., Philadelphia. 1837. Dec. 14	35	Traumatic bungling electrolysis, 7 yr.	1	7	0	13	*	4 mo.	Enlarged to 25; well	Reports well, by letter, 1890	$2\frac{1}{2}$ yr.
224	R. J., Colchester, Conn., 1887, Dec 14	50	Traumatic retention, cystitis, orchitis, 3 yr.	1	7	17	2	14	2 wk.	Improved to 20; could not come again	July, 1888	6 mo.
225	G. A. S., N. Y. C., 1887, Dec. 30	28	Gleet continuous, for 2 yr.	2	3, 5	17	6	8	2 mo.	Enlarged to 28; well	Reexamiued Feb. 13, 1889	1 yr.
226	Dr. J. S. C., N. Y. C., 1888, Jan 3	47	Inflammation, urethrotomy, 10 yr.	2	3, 5	21	8	7	2 mo.	Enlarged to 32; well and married	Reexamined 1892	4 yr.
227	A. D., Greenville, N. J., 1888, Feb. 3	49	Gleet, two urethrotomies, 10 yr.	2	$2\frac{1}{4}$, $5\frac{1}{2}$	21	5	*	3 mo.	Enlarged to 30	Reexamined, March 14, 1890	2 yr.
228	J. D., N. Y. C., 1888, Feb. 6	46	Gleet, retention, urethrotomy, 17 yr.	2	$4\frac{1}{4}$, $5\frac{1}{4}$	8	14	11	4 mo.	Improved. 27; patient was transferred and spirited away by a surgeon.		

* Irregular.

STATISTICS, SUMMARY—(*Continued*)

Number	Patient's Initials, Residence, Date of First Visit	Age—Years	Cause, Duration, Complications of Stricture	No. of Strictures Found	Distance from Meatus, Inches	Size of Stricture, Fr. Scale No.	Treatment: How Many Séances	Treatment: Average Intervals Days	Treatment: Time of	Sequel and Caliber of Urethra when Discharged, French Scale No.	Last Heard From After Treatment	Time After Discharge Without Relapse
229	F. S. B., Hackensack, N. J., 1888, Feb. 13	23	Urethritis, 1 yr.	1	5	17	6	14	3 mo.	Enlarged, 28, well	Reexamined Oct. 4, 1892	4½ yr.
230	J. G., Topeka, Kansas, 1888, Feb. 27	36	Urethritis, 2 yr.	2	2½, 5	18	2	8	1 wk.	Improved, 25	March, 1889, No. 25 passed	1 yr.
231	R. L. C., N. Y. C., 1880, March 4	35	Strong injections, 5 yr.; nervous prostration and spasm	2	2¼, 6½	9	12	*	4 mo.	Little improved to 17; patient absented himself	Intercurrent sickness; no material success, 1889.	
232	G. B. C., Montreal, 1888, March 30	54	Traumatism, prostatitis, cystitis; urethrotomy, 7 yr.	3	2½, 2¼, 6¼	17	7	7	6 wk.	Enlarged to 25; is well	By family physician, 1891	3 yr.
233	A. J. S., Brooklyn, 1888, April 2	60	Unknown; cystitis, prostatitis, 10 yr.	1	3	20	5	7	1 mo.	Improved to 25; gone South	Not heard from.	
234	V. S. N., N. C., 1888, April 27	40	Traumatism, 10 yr.; urethrotomy	3	2½, 4½, 5½	15	8	6	1½ mo.	Enlarged to 25; gone home	By letter, 1891	3 yr.
235	C. H. H., N. Y., 1888, April 30	34	Prolonged gleet, 5 yr.	2	4, 5	11	6	6	1 mo.	Enlarged to 25; well	Reexamined Sept. 1882	4 yr.
236	G. T., N. Y. C., 1888, May 2	39	Gleet, spasm, 8 yr.	2	3½, 5	6	15	*		Enlarged to 28; well	Reexamined Jan. 1892, well; also 1890, 1891	4 yr.
237	C. S., N. Y. C., 1888, May 14	70	Inflammation, retention, enlarged prostate, 6 yr.	2	4½, 6¼	17	6	10	2 mo.	Enlarged to 26; capacity of meatus; well	Reexamined Sept. 9, 1889	1½ yr.
238	G. L., Florida, 1888, May 18	26	Urethritis, epididymitis, 1½ yr.	2	4¼, 5½	21	3	5	10 da.	Enlarged to 28; gone home	Not heard from.	
239	Dr. E. H., Brooklyn, 1888, May 21	48	Gleet, 8 yr.	2	3½, 5¼	18	6	10	2 mo.	Enlarged to 28; well	Reexamined Dec. 17, 1890†.	
240	J. T. M., N. Y. C., 1888, May 19	52	Gleet, 12 yr.; urethrotomy	3	3½, 5¼, 7½	20		*		Enlarged to 25; well	Reexamined Feb. 1892	4 yr.
241	J. Z. A., Hackensack, 1888, May 26	24	Urethritis and inflammation, 9 mo.	2	3, 5	11	8	7	2 mo.	Enlarged to 25; capacity of meatus	Reexamined May 20, 1890	2 yr.

* Irregular. † Life insurance physician accepts and finds no stricture.

242	W. A. M., Redbank, 1888, June 19 . . .	43	Strong injections, 20 yr.	2	3, 5	9	11	8	3 mo.	Enlarged to 25 .	Saw patient off and on to 1892; is well .	4 yr.
243	Dr. R. W., N. Y. C., 1888, July 21 . .	31	Urethrotomy, no venereal disease, 1 yr. .	1	3½	21	2		2 mo.	No. 25, passed easy .	Saw patient often; is well	4 yr.
244	M. B. M., City, 1888, July 25	45	Urethritis, 10 yr. . .	1	3½	25	8	7	2 mo.	Enlarged to 30; is well	Reexamined July 19, 1889	1 yr.
245	E. B., N. Y. C., 1888, Aug. 14 . . .	23	Urethritis, 5 yr. .	4	1½, 4, 4¾, 5½	11	7	7	2 mo.	Enlarged to 25 . .	Heard from off and on	3 yr.
246	J. H., Rahway, N. Y., 1888, Sept. 1 . .	28	Urethritis, 2 yr.; urethral abscess; cystitis	1	5	15	6	7	1½ mo.	Enlarged to 28 . .	Not heard from.	
247	A. C., N. Y. C., 1888, Nov. 3	31	Prolonged gleet, 8 yr. .	1	4¼	20	4	7	1 mo.	Enlarged, 25; patient left content . .	Not heard from.	
248	H. R. C., N. Y., 1888, Sept. 23	52	Inflammation, 30 yr. .	3	3, 5, 7	0	6	7	1½ mo.	Much improved to 24: patient feels too well	Not heard from.	
249	T. M., N. Y. C., 1888, Sept. 25	26	Granular urethritis, gleet, 6 yr. . .	1				*		No. 27 passed size of meatus; is well .	Reexamined May, 1891	2½ yr.
250	L. B., N. Y. C., 1888, Oct. 11 . .	36	Urethrotomy, 9 yr. .	1	3	25	6	15	3 mo.	No. 32 passed easy; is well .	Reexamined Feb. 20, 1891 . . .	2½ yr.
251	Dr. A. W., Iowa, 1888, Oct. 30 .	37	Retention; cerebrospinal meningitis; 12 yr.	1	6¼	20	4	7	1 mo.	No. 28 passed easy; is well . . .	Not heard from.	
252	R. M. C., Texas, 1888, Nov. 10	52	Urethritis, gleet, 32 yr.; urethrotomy . . .	4	1½, 2¼, 4, 6¼	21	6	10	2 mo.	Enlarged to No. 30; well; gone home .	Reexamined No. 30, May 14, 1891 . .	2½ yr.
253	F. S., N. Y. C., 1888, Nov. 28 . .	24	Urethritis, strong injections, 1½ yr. .	2	1¼, 5	11	7	†	4 mo.	Enlarged to No. 28;	Reexamined Oct. 1889	1 yr.
254	H. J., Brooklyn, 1888, Dec. 16	26	Gleet, 1 yr. . .	3	2¾, 4, 5½	6		‡		Relapses in intervals; improved to 20 . .	August, 1890, seen by Dr. Waite.	
255	K. B. M., Brooklyn, 1888, Dec. 22 . .	39	Gleet, 16 yr.; urethrotomy .	1	5½	17	5	7	1 mo.	Enlarged, No. 28 . .	Not heard from.	
256	J. H. H., Troy, 1888, Dec. 29	39	Gleet, 16 yr.; spasm of bladder . .	2	2¼, 5	13	7	7	1½ mo.	Improved to 26. Meatus full capacity	Not heard from.	
257	C. A. P., N. Y. C., 1889, Jan. 4 . . .	36	Urethritis, caustics; 7 mo.; cicatrix of meatus . . .	2	1, 5	6	5	6	1 mo.	Improved, 25; much as meatus will permit	Dr. McLaury reports him well, Sept. 1892	3½ yr.
258	G. P., West Indies, 1889, Jan. 15 . .	33	Neglected inflammation; 3 years' congenital phymosis, with adhesions . .	2	4, 6¾	14	4	5	1 mo.	Improved, 23; patient content, and went to sea . . .	June, 1890, not worse	1 yr.

* Large caliber; treated also per endoscope; irregular. † Irregular. ‡ Irregular and long intervals.

STATISTICS, SUMMARY—(*Continued*)

Number	Patient's Initials, Residence, Date of First Visit	Age—Years	Cause, Duration, Complications of Stricture	No. of Strictures Found	Distance from Meatus, Inches	Size of Stricture, Fr. Scale No.	Treatment: How Many Séances	Treatment: Average Intervals, Days	Treatment: Time of	Sequel and Caliber of Urethra when Discharged, French Scale No.	Last Heard From After Treatment	Time After Discharge Without Relapse
259	J. W. S., Sprankles, Pa., 1889, Jan. 19	23	Gleet, orchitis, 4 yr.	1	6	11 23	3	10	1 mo.	Enlarged to No. 30; stricture cured	March, 1891, by letter	2 yr
260	C. F. H., N. Y. C., 1889, Jan. 21	31	Gleet, caustics, 3 yr.	1	3	20	6	*	3 mo.	Enlarged to 28; capacity of meatus	Reexamined last Feb. 17, 1890; well	1 yr.
261	W. E. N., City, 1889, Jan. 21	39	Gleet, urethrotomy; 9 yr.	2	3, 6	8	7	8	2 mo.	Improved, No. 25	Not heard from.	
262	A. C., City, 1889, Jan. 27	44	Cystitis, prostatitis; no venereal disease, 9 mo.	3	2, 5, 8	20	6	12	2½ mo.	Improved, No. 25	February, 1890	1 yr.
263	A. C. B., N. Y. C., 1889, Feb. 3	27	Strong injection; 6 mo.	1	5	13	6	7	1½ mo.	Enlarged to No. 28	Reexamined June 14, 1890; well	1½ yr.
264	D. M. L., New Haven, 1889, Feb. 26	47	Not well known, 10 yr.	1	6	20	4	7	1 mo.	Enlarged to No. 25	Reexamined Feb. 13, 1892; well	3 yr.
265	J. W. F., Savannah, 1889, March 2	33	Neglected inflammation, 15 yr.	3	3, 5, 7	11	7	7	1½ mo.	Enlarged to No. 28	Gone South; not heard from.	
266	Dr. G. P. H., Galveston, 1889, March 2	36	Nervous disease, inflammation, 9 yr.	1	3¾	20	4	5	1 mo.	Enlarged to No. 28, utmost capacity of meatus	Doctor wrote he had no relapse	1 yr.
267	Dr. F. B. G., N. Y. C., 1889, March 13	44	Organic cartilagenous stricture, 21 yr.	2	3, 5¾	15, 0	16	8	4 mo.	Enlarged, No. 28; well	Doctor says he can pass 28 easy; June, 1890; well	1 yr.
268	G. M., N. Y. C., 1889, May 6	51	Gleet, 6 yr.	1	5	18	7	9	2 mo.	Enlarged, No. 28; well	Reexamined April 16, 1891; well; No. 28	2 yr.
269	A. B., Bayonne, 1889, June 2	41	Neglected urethritis, 23 yr.; urethrotomy	3	3, 5, 6	5	10	*		Enlarged to 28; well and married	Family physician reports well, June, 1891	2 yr.
270	C. A. A., Boston, 1889, June 29	32	Traumatism, 5 yr.	2	2¼, 5½	20	5	8	1½ mo.	Enlarged, No. 28; well	Reexamined Sept. 20, 1890; well; No. 28	2 yr.
271	B. R., Hackensack, 1889, June 22	21	No venereal disease. Cystitis, recent	1	4	4	5	7	1 mo.	Enlarged, No. 25	Heard from	½ yr.

* Irregular.

272	M. J. T., N. Y. C., 1889, Sept. 12	36	Strong injections, 8 yr.; prostatitis	2	2, 4	14	11	*		Enlarged to No. 26; gone to St. Domingo	Reexamined July, 1891	$1\frac{1}{2}$ yr.
273	D. D. B., Montreal, 1889, Sept. 15	31	Traumatic, 15 yr.	2	3, $5\frac{1}{2}$	6	4	5	$\frac{1}{2}$ mo	Improved to No. 21; gone home	His physician reported well; Feb. 1891	$1\frac{1}{2}$ yr.
274	C. H., Croton, 1889, Sept. 20	47	Inflammation, cystitis, 10 yr.	3	2, 4, 5	11		†		Improved to No. 20	Sept 23, 1892; reports well	3 yr.
275	E. L. T., N. Y. C., 1889, Sept. 28	33	Strong injections, 4 yr.	2	2, $4\frac{1}{2}$	21	4	9	1 mo.	Enlarged to No. 26; is content	Reexamined, Jan., 1890. Seen Sept. 6, 1892; well	3 yr.
276	C. H., Brooklyn, 1889, Nov. 21	48	Strong injections, 30 yr.; urethrotomy	2	3, 4	23	4	7	1 mo.	Enlarged, No. 30; well	Reexamined April 2, 1892	$2\frac{1}{2}$ yr.
277	H. S., N. Y. C., 1889, Dec. 11	20	Gleet, $1\frac{1}{2}$ yr.	1	4	21	4	14	2 mo.	Enlarged, No. 26; endoscope, etc.	Friends report him well; Nov., 1891	2 yr.
278	Dr. H. H., Brooklyn, 1889, Dec. 22	39	Gleet, 5 yr.	1	$4\frac{1}{2}$	22	6	7	2 mo.	Enlarged, No. 30; well	Reexamined March, 1891; well	1 yr.
279	J. R. P., 1890, Jan. 16	37	Strong injections, 4 yr.	2	$2\frac{1}{4}$, 6	21	7	9	2 mo.	Enlarged, No. 28; well	Not heard from.	
280	E. B. D., Wisconsin, 1890, March 21	40	Urethritis, prostatitis; 2 yr.	2	$1\frac{3}{4}$, $4\frac{3}{4}$	9	10	9	3 mo.	Enlarged, No. 28; well	Reexamined April, 1891	1 yr.
281	N. P. S., Woodstock, 1890, March 29	36	Inflammatory discharges, 3 yr.	2	$2\frac{1}{4}$, $4\frac{1}{2}$	‡	4	18	$2\frac{1}{2}$ mo.	Improved to No. 20; gone home	Prevented from coming again to N. Y.	
282	E. R., Dallas, Texas, 1890, May 12	50	Inflammations, uncertain cause, 20 yr; prostatitis	1	$6\frac{1}{2}$	12	8	6	$1\frac{1}{2}$ mo.	Enlarged, No. 28; well	Not heard from.	
283	A. L. B., Bayonne, 1890, Sept.	48	Gleet, 3 yr.; prostatitis	1	$7\frac{1}{2}$	17	7	8	2 mo.	Enlarged, No. 28; well	By family physician, March, 1892	$1\frac{1}{2}$ yr.
284	J. M. L., Watertown, 1890, Oct. 9	75	Inflammation, cystitis, retention, 15 yr.	2	$4\frac{1}{2}$, $5\frac{1}{2}$	17	6	†	1 yr.	Much Improved; No. 26; left for home	By letter, well; 1892	1 yr.
285	L. S. W., City, 1890, Oct. 11	73	Gleet, retention, prostatic hypertrophy, 12 yr.	2	5, $6\frac{1}{4}$	14	4	7	1 mo.	Much improved and prostate reduced	Not heard from.	
286	J. B., Texas, 1890, Jan. 3	24	Urethritis, urethral, fistula, 7 yr.	1	7	8	8	8	$2\frac{1}{2}$ mo.	Enlarged, No. 28; well	Reexamined April 15, 1892	1 yr.
287	W. B. T., White Plains, 1891, Jan. 15	48	Urethritis, cystitis, 20 yr.	2	2, 7	17	12	*	4 mo.	Enlarged, No. 28; well	Reexamined May 18, 1892	1 yr.
288	W. H. S., N. Y. C., 1891, Jan. 22	47	Gout, urethritis, cystitis; 2 yr.	2	$2\frac{1}{4}$, $5\frac{1}{2}$	17	11	*	5 mo.	Meatus won't admit larger than 24; well	Seen off and on: is well; March 1892	1 yr.
289	T. B., Roanoke, 1891, Feb. 7	41	Strong injections, 1 yr.	2	$2\frac{1}{4}$, $5\frac{1}{2}$	22	3	5	2 wk.	Enlarged, No. 28	Written is well; Dec. 4; 1891	10mo.

* Irregular. † Irregular and in long intervals. ‡ Filiform.

STATISTICS, SUMMARY—(*Continued*)

Number	Patient's Initials, Residence, Date of First Visit	Age—Years	Cause, Duration, Complications of Stricture	No. of Strictures Found	Distance from Meatus, Inches	Size of Stricture, Fr. Scale No.	Treatment: How Many Séances	Treatment: Average Intervals, Days	Treatment: Time of	Sequel and Caliber of Urethra When Discharged, French Scale No.	Last Heard From After Treatment	Time After Discharge Without Relapse
290	J. P., Katonah, 1891 Feb. 25 .	29	Inflammation, cause uncertain, 6 mo. . .	1	6¾	*	5	12	2 mo.	No. 28 passes easy .	Reexamined Sept. 2, 1892	1½ yr.
291	F. H. S., 1891, March 9	46	Gleet continued 10 yr.	2	3, 5	17	8	7	2 mo.	No. 27, utmost capacity of meatus; well	Not heard from.	
292	H. N. P., N. Y. C., 1891, March 31 . . .	31	Gleet, 12 yr.	2	2¾, 5¾	17	8	7	2 mo.	No. 28; well	Well; heard direct and indirect, July, 1892	1 yr.
293	J. L. M., Brooklyn, 1891, March 28 . .	66	Rectal abscess, urethral fistula, strong injections, 25 yr. . . .	1–6		†			4 mo	No. 26, the capacity of meatus	Reexamined May 8, 1892	1 yr.
294	W. H. B., 1891, April 18	33	Urethral abscess, 5 yr.	1	6½	18	3	7	½ mo.	Enlarged to No. 25; much improved	Not heard from.	
295	C. D. K., S. C., 1891, May 10	33	Traumatism by instruments, 6 yr.; urethrotomy	2	4, 6½	18	6	16	3 mo.	Enlarged, No. 28 .	Reexamined May 22, 1892	1 yr.
296	W. M. H., Chicago, 1891, May 12 . . .	80	Urethritis, 53 yr.; urethrotomy; perineal section	3	3, 4½, 5½	14	3	7	½ mo.	Enlarged, 23; patient gone West; much improved . .	Not heard from.	
297	G. A. B., City, 1891, May 23	50	Gleet, 2 yr.	1	6	18	3	10	1 mo.	Improved, 26; feels well enough . .	Reexamined Dec. 16, 1891	7 mo.
298	W. K., City, 1891, June 2	45	Urethritis, 5 yr. .	3	3¾, 4¾, 6	21	6	14	3 mo.	Enlarged, 28; endoscope treatment .	Reports well; Dec., 1891	7 mo.
299	W. T. C., Trenton, 1891, June 19 . . .	30	Urethritis, gleet, 12 yr.	1	5½	21	3	6	½ mo.	Enlarged, 28; content	Not heard from.	
300	E. D. W., N. Y. C., 1891, Aug. 15	36	Gleet, 5 yr.	2	2¾, 5	17, 15	12	‡	6 mo.	Enlarged, 28; well .	Saw patient who is well, Feb., 1892 .	8 mo.

* Large caliber. † Calcareous; irregular. ‡ Irregular.

REMARKS ON THREE HUNDRED CASES

95. In the selection of each series is a little difference. The first hundred cases was reported to the American Medical Association, in Cleveland, 1893.* The principal feature was to show that no relapse of the malady occurred after the stricture had been cured by means of the electrolysis. As the meaning of the word *cured* may be interpreted by some differently than by others, it will be more explicit to define the meaning, viz.: no contraction of the caliber of the urethra took place, and after the patient had been dismissed as well, to his own satisfaction, the same number of sound, or catheter, that was used the last time in treatment would easily pass after a year, or even many years. These cases were naturally not consecutive cases, but collected from consecutive cases for the purpose, and had to meet the following conditions: (1) That the patients be under treatment regularly, and for a reasonable time; (2) that they were to be discharged cured, or at least so improved that they were content with the result and did not wish any further treatment or improvement; (3) that they were to be cases that were heard of afterwards by reliable information; mostly by reexamination. Some of these patients came repeatedly for such a reexamination. (4) The proof of no relapse was, that the same number of sound was used in the reexamination that passed the last time at the close of the treatment, that is, if the caliber of the urethra was enlarged to a No. 26 French, the same number passed again after 3 to 11 years, respectively.

96. The second hundred cases† was selected in a different way. It consisted of the experience of a later period, the narrative of almost consecutive cases taken from the note-book, relating to all such cases that had remained long enough under treatment to warrant a result and in which the necessary information had been furnished and recorded; on the other side, omitting cases that had not been long enough under

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*Journal American Medical Association, April 25, 1885; New England Medical Monthly, August, 1885.

†Journal of American Medical Association, September 24, 1887.

treatment, or only seen without treatment, and in which the record is sufficient. The patients were dismissed or stopped treatment themselves when they felt comfortable and well, had a caliber of the urethra that enabled them to void freely a good large stream, and, if they wanted, could exercise a sexual intercourse. The result of such treatment is noted under the heading "Sequel and Caliber of Urethra When Discharged." The number of the electrode used is stated according to the French scale.

97. The third hundred cases differs somewhat from the first two, as this is the hundred consecutive cases treated by us, and even if treated only temporarily, the result is stated regardless of whether the patient remained under treatment long enough for an expected favorable result or left for some reason before being cured. Excluded from the consecutive order were only consultations, or patients that were seen once and came for an examination or diagnosis.

RECAPITULATION

98. The enlargement of the caliber of the urethra by the electrolytic treatment was as follows:

Strictures that admitted no instrument were enlarged from No. 24 to 28 French, respectively.

Strictures that admitted a No. 4 instrument were enlarged from No. 14 to 28 French, respectively.

Strictures that admitted a No. 6 instrument were enlarged from No. 17 to 28 French, respectively.

Strictures that admitted a No. 7 instrument were enlarged to No. 20.

Strictures that admitted a No. 8 instrument were enlarged from No. 21 to 28 French, respectively.

Strictures that admitted a No. 9 instrument were enlarged from No. 17 to 28 French, respectively.

Strictures that admitted a No. 11 instrument were enlarged from No. 20 to 28 French, respectively.

Strictures that admitted a No. 12 instrument were enlarged to No. 28.

Strictures that admitted a No. 13 instrument were enlarged from No. 26 to 28 French, respectively.

Strictures that admitted a No. 14 instrument were enlarged from No. 26 to 28 French, respectively.

Strictures that admitted a No. 15 instrument were enlarged from 25 to 28, respectively.

Strictures that admitted a No. 17 instrument were enlarged from No. 20 to 28, respectively.

Strictures that admitted a No. 18 instrument were enlarged from No. 25 to 32, respcctively.

Strictures that admitted a No. 20 instrument were enlarged from No. 25 to 28, respectively.

Strictures that admitted a No. 21 instrument were enlarged from No. 25 to 32, respectively.

Strictures that admitted a No. 23 instrument were enlarged from No. 27 to 30 French, respectively.

Strictures that admitted a No. 25 instrument were enlarged from No. 30 to 32, respectively.

99. The result of the enlargement of the caliber of the urethra varied according to circumstances; as, necessities, wishes of the patients, time allowed for treatment, nature of the stricture, complications, general condition as to occupations, vices or virtues of the patients. But, results must be considered very good, even by chronic grumblers, if a caliber of an urethra can be cnlarged to a No. 28 French, when at the first visit no instrument would pass, and experts have tried in vain before. In some cases, the family physician had tried for weeks; in others, celebrated professors were given chances without being able to pass any instrument, and the disposition of the cases were the advice of perineal section. In some cases, this advice by the family physician was accompanied by a written introduction to a first-class operator, etc. In all such cases, when no medical hand could pass the stricture with an instrument, it was passed successfully by the power of the "electrolysis," which acted as a chemical absorbent, and not as a dilator, as some kind friends have suggested. If, in these cases, dilatation could have been used, why did the experts and surgeons not do it? All these

are facts that can be verified by reliable witnesses, and there can be no doubt that the electrolysis did the work, which could not be done by pressure or dilatation.

The duration of the strictures at the time the patients presented themselves for treatment varied from 3 months to 53 years, and in recapitulating we find two cases that had a standing of 3 months; three cases, 6 months; two cases, 7 months; one case, 9 months; nine cases, 1 year; eleven cases, 2 years; eight cases, 3 years; five cases, 4 years; eleven cases, 5 years; five cases, 6 years; four cases, 7 years; five cases, 8 years; three cases, 9 years; ten cases, 10 years; one case, 11 years; five cases, 12 years; four cases, 15 years; two cases, 16 years; two cases, 17 years; five cases, 20 years; one case, 23 years; one case, 24 years; one case, 32 years; and one case, 53 years.

100. The *percentage* of single or multiple strictures is given below:

Series of Cases	Single	Multiple	Total Number of Strictures
First hundred	42	58	189
Second hundred	21	79	230
Third hundred	34	66	192
Average per hundred in the three . .		32	67

We may expect nearly one-half of patients presenting themselves having single strictures. The increase of multiple strictures in these statistics may arise from the fact that more bad cases were transferred to us.

101. The *number* of strictures in one individual we find as follows:

Number of Strictures	First Hundred Cases	Second Hundred Cases	Third Hundred Cases	Average Per Cent.
One in . .	42	21	34	32
Two in	34	43	43	40
Three in	17	26	19	21
Four in .	5	7	4	10
Five in . . .	2	1	0	1
Six in	0	2	0	1

102. The *location* of the strictures was found in all parts of the urethra, from the meatus to more than 8 inches from it, as follows:

Location	First Hundred Cases	Second Hundred Cases	Strictures in Third Hundred Cases	Average
At meatus or less than 1 inch from meatus . .	8	9	1	6
At 1 inch or less than 2 inches from meatus . .	12	12	5	10
At 2 inches or less than 3 inches from meatus . .	31	24	25	27
At 3 inches or less than 4 inches from meatus . .	25	41	31	32
At 4 inches or less than 5 inches from meatus . .	42	30	35	36
At 5 inches or less than 6 inches from meatus . .	37	46	51	45
At 6 inches or less than 7 inches from meatus . . .	24	40	30	31
At 7 inches or less than 8 inches from meatus . . .	0	20	14	11
At 8 inches or more from meatus	10	8	1	6

103. Situation. — The greatest number of strictures were from 4 to 6 inches, or in the first part of the urethra; in the membranous part, 15 per cent.; in the prostatic part, 5 per cent. This combined statistic of these three hundred cases confirms the observations made at the report of the first series, that strictures appear in every portion of the urethra, about 15 per cent. in the membranous and about 5 per cent. in the prostatic portion, some of the latter being of traumatic origin. It seems to be a mistake to believe that there are no strictures in the prostatic portion of the urethra, and that the largest number are situated within 3 inches from the meatus.

Séances, intervals, and time-treatment average exactly alike in all series reported. From one to ten operations, in some cases, even more, were necessary, from which fact one may draw the conclusion that the average number of séances was

five to six for each case. The treatment in each case averaged 2 to 3 months. Long intervals between the séances and weak currents are the most important factors in these operations. The intervals should be once a week or more, but in case of necessity may be shortened; each séance should last from 2 to 10 minutes. The electric current is from 3 to 5 milliamperes of a good galvanic battery, having a steady current. Precision and measurement of the electric current are important.

104. Objections—Unjustly Made.—In reality there can be no valid objections to the method of electrolysis in the treatment of urethral strictures, and those that have been raised from time to time come either from men entirely ignorant of the first physical laws of electricity or from such as have had a personal interest or feeling in the matter. To the latter class in the opposition belong some surgeons of high standing, who are wedded to the knife, have not tested the electrolysis, and hence are opposed to any innovation. Most of such objections are unfounded, based on false theories, or are too trivial and too ludicrous to be considered. Some have even the stamp of misstatements purposely made. One friend objects to the treatment because it does not always cure a prostatitis or any other discharge. Of course it does not always. Discharges will only be cured if their existence is caused by stricture; but if there are granulations, or other causes, electrolytic treatment has nothing to do with it. Some are aggrieved to hear that to succeed it is necessary to understand electricity and the handling of the genito-urinary instruments. Now, there is scarcely a profession, business, or even common labor that can be exercised without an apprenticeship, and in any vocation expertness is needed to be successful. The same objection could be raised to any operation, or even to the practice of medicine.

A London surgeon does not like the long intervals between séances, without giving any reason for it. If necessary he may operate at shorter periods. One distinguished operator, who is most persistent in his opposition to this method, argues as follows: "Electrolysis is a heat; heat burns; burns make cicatrices; cicatrices make every stricture worse; ergo,

electrolysis is no good!" Now, that surgeon should know better after having read articles on the subject and heard explanations. It is distinctly advised, always practiced, and insisted on to use weak currents from 2½ to 5 milliamperes, so that the electrolysis acts as a chemical decomposition by absorption, which never burns or destroys tissues. If some surgeons use too strong currents, or the positive, instead of the negative, pole, they make gross mistakes, must necessarily fail, destroy tissues, and ruin their patients. If professors and others have made such mistakes and failures, it is to be lamented, but does not harm the reputation of a good method which is approved by acknowledged successes in a large number of cases all over the world. It is more than ludicrous to read the report of an operator that has the naïveté to measure electricity by a thermometer.

105. Failures.—As the success is dependent on the laws of physics and chemistry, there should be no failures if the treatment is carried on according to such laws. As there have been reports of failure even by excellent medical practitioners, the cause must be in either of the following four reasons: (1) Incompetence of the operator; (2) mismanagement of the case; (3) wrong diagnosis; (4) faulty instruments.

1. *Incompetence of Operator.*—To succeed, the operator must be an accomplished surgeon and electrician, knowing the difference between a galvanic and an induced current, in the first place, and, secondly, having some knowledge of the different results obtained by each current on animal tissue. He must be an accomplished surgeon, so as to be able to lightly introduce instruments into a diseased urethral canal and safely guide them through all parts of an abnormal or pathological passage.

2. *Mismanagement.*—Others, though having enough knowledge of the subject, will fail on account of carelessness. They do not give time to the details, are without any perseverance, and become easily discouraged if their first trials do not give them perfect results. From a letter of a prominent physician it was plainly shown that the doctor, in treating the case, violated nearly every rule that would lead to success.

First, he passed an electrode that gave pain; pain should not

be given under any circumstances. If soreness is already present, it should be removed by appropriate remedies. *Second*, he did wrong to give an anesthetic; where there is no pain an anesthetic is not required. The patient should be able to express his feeling as a partial guide to the operator. *Third*, the current used was entirely too strong. *Fourth*, more than one electrode was passed at a single sitting. The invariable rule is that no two instruments should be passed, even for several days after the operation. *Fifth*, 2 days later an English sound was passed, making the stricture bleed, which showed that damage was being done to the urethra. No. 8 was selected after No. 9 had passed 2 days previously, which is another mistake. The object is to enlarge the caliber of the urethra, during each subsequent sitting. This treatment also brought on two attacks of urethral fever, which will never happen with proper care. *Sixth*, instead of allaying pain and irritation, the doctor made matters worse by using the sound and producing more irritation.

Notwithstanding all this mismanagement the patient and doctor were pleased with the improvement. One year later the operator wrote, however, that the case did not turn out as well as he could have wished. He acknowledged his errors and reported other more successful cases.

3. *Wrong Diagnosis.*—This consists in attempts at the electrolytic treatment when no stricture exists or is present or the impossibility to pass spasmodic action with electrolysis.

4. *Faulty instruments* certainly may become a cause of failure, though an expert operator may partly overcome this cause by the skilful handling of even rude instruments. Nevertheless, a careful man will select the best instruments as an important factor to his success. Many instrument-makers make cheap, faulty articles or useless alterations, in order to compete with honest work.

106. Relapses.—These do not take place when the stricture has been cured and the patient discharged. The reason for such a statement is that in a cure the pathological condition has been absorbed by the decomposition, which is an entire removal of the stricture and its cause. The conditions for declaring

patients cured are: (1) The patients being under treatment regularly, and for a reasonable time. (2) That they were to be discharged as cured, or at least so improved that they were content with the result and did not wish any further treatment or improvement. (3) That they were to be cases that were heard of afterwards by reliable information. Some of these patients came repeatedly for such reexamination. (4) That a reasonable time had been allowed between the discharge, when cured, and the reexamination, which in these cases was from 3 to 11 years, respectively.

The proof of no relapse was that the same number of sound was used in the reexamination that passed the last time at the close of the treatment, that is, if the caliber of the urethra was enlarged to a number 26 French, the same number passed again after 3 to 11 years, respectively; and at the present time, patients can be shown who, after being cured, have been well without a relapse for 26 years.

Now, in conclusion, electrolysis of urethral stricture must and will succeed, in proper hands, in every case that is intelligently and judiciously undertaken. The operation itself needs a clear head, a steady hand, fingers that both see and feel, and patience and good discrimination in the application of the strength of current and length of sitting. In the strictest sense of the word, there can be no failures in dissolving the dense tissue that constitutes a stricture, for electrolysis is based on a fixed chemical action of the constant current on these animal tissues. *Electrolysis cannot fail, but operators may, and do.*

REVIEW OF OTHER METHODS OF TREATMENT

107. The above method of electrolysis for the treatment of urethral stricture has been described in detail, as it has been practiced successfully in many thousand cases by different operators and is therefore recommended. There are other methods that may be used in certain cases, and are mentioned here in order that the student may know of such methods.

108. Fort's Linear Electrolysis. — Fort's so-called *linear electrolysis* consists in the use of an instrument like an

elastic catheter, with a filiform attachment, Fig. 26. Into this catheter, at the lower end, is set a triangular platinum knife. The shaft of the instrument has a caliber of a No. 11 French, and the knife cuts to No. 26 French. A current of from 10 to 20 milliamperes is used for a short time, from 10 to 60 seconds, during which the knife is pushed through the stricture. This instrument has a striking similarity with Doctor Butler's instrument, described in the American Journal of Electrology and Neurology, New York, Vol. I, No. 2, October, 1879, page 95.

Fort's operation is made in one séance, and is in reality a divulsion, and *not* an electrolysis. McNamara's divulsion has done well in some cases, but in others has failed. More could

FIG. 26
Urethral Electrolyseur of Doctor Fort

be said about Fort's linear electrolysis, but after careful consideration, the conclusions are: (1) That the current of 10 milliamperes can give very little, if any, chemical decomposition in 30 seconds. (2) That a strong current may cauterize, but is not effective in 30 seconds. (3) That the action is in reality a divulsion, which, under certain conditions, is not free from danger. (4) That the instrument has a similarity with Butler's device. (5) That the instrument is patented. (6) That the procedure is not an electrolysis, rather uncertain, and we cannot recommend it.

109. Gradual Dilatation.—This is an ideal treatment, and may succeed in some contraction of the mucous lining, but in an organic stricture, with new fibroid tissues formed in the surroundings of the urethra, it will fail. The dilatation acts only temporarily like an elastic band, which retracts as soon as the dilator is removed.

110. Cutting Operations (Urethrotomy).—These can only divide the obstruction in one line and in one place,

leaving the other parts of the constriction intact. Even if an incision enlarges the caliber, one of two things will follow: either the divided surfaces come in opposition and then heal by first intention, thereby restoring the stricture just as it was before the cutting operation, or the divided surfaces are kept apart and stretched, in which case the healing must take place by granulations and subsequent formation of cicatrices, leaving the patient uncured and in a condition still requiring the use of a sound. This is admitted even by the principal advocates of cutting operations. Some voices in the profession have protested against urethrotomy, and such have been mentioned.

111. Rational Treatment of Strictures of the Male Urethra.—John Harvey Girdner, M. D., says: "From the standpoint of antisepsis, the operation of internal urethrotomy is a most glaring inconsistency, and a violation of the known laws of nature, as applied to this part of the organism. You cannot cut a stricture internally, without at the same time cutting some of the sound tissue in its neighborhood. Should the patient escape these dangers of infection, the worst is to follow, for after this traumatism, nature adopts her old method of preserving the integrity of the urethra, and deposits more lymph at the seat of the stricture and in the adjoining healthy tissue, which in time organizes, and contracts; and not the old stricture, but a tighter one is formed, and the last state of that urethra is worse than the first."

Dr. J. P. Tuttle* said, at the meeting of the New York County Medical Society, May 25, 1896, that the whole principle of dilatation and internal urethrotomy was wrong. The success of internal urethrotomy depended, not on the thoroughness of the cutting, but on the thoroughness with which the urethra was dilated after the internal urethrotomy. Dr. N. Senn declared cutting-operations in strictures a failure, in his essay at the New York State Medical Association, held October 28, 1891. The objections to internal urethrotomy are: (1) It does not cure; (2) chordee is a frequent sequence; (3) the mortality is about 4 per cent.

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*American Medico-Surgical Bulletin, June 6, 1896, page 794.

DISEASES OF THE URETHRA

GONORRHEA, OR URETHRITIS

112. In the acute stage of this disease, very little can be done, as it causes pain that the patient will not endure. An authority of France, Doctor Doumer, has reported success by the employment of high-frequency currents.

Metallic electrolysis has also been used for the chronic form of urethritis. This is possible, but we cannot recommend it, as it may cause severe contractions of the urethra.

Dr. H. T. Webster, of Oakland, Cal., reports* decided success in the treatment of gonorrhea with the faradic current. He introduced an urethral electrode into the urethra an inch, and then turned on a current of faradism, the electrode being connected with the positive pole, while the negative pole was a sponge held in one hand. The pain was reduced in a few minutes, and 20 minutes of the faradization relieved entirely; a good night followed with comfort. Ten days were needed for a complete cure, during which time daily applications of the faradic current were given. No sequel of gleet followed, the patients making excellent recovery.

GLEET

113. Several authors have reported good results with the faradic current. The late Doctor Steavenson, of London, used the negative pole in the urethra with an urethral electrode connected with the negative pole. The electrode connected with the positive pole was placed on some indifferent part of the body, but by preference over the lumbar plexus, as possibly the effect of the electricity on the nervous supply of the urethra may be beneficial. As a rule the benefit arises from a stimulation of the mucous membrane and the glands. A sound may be used, but it is still better if a part of such electrode is insulated and only 2 or 3 inches used for direct contact with the mucous membrane of the urethra with a current from the

*Massachusetts Medical Journal, Vol. 14, No. 8.

fine-wire coil of the physician's induction-apparatus. The pole for the urethra must be selected according to indications, with a preference for the positive pole. The applications must be given for 10 minutes every third day.

114. Urethritis Chronica Glandularis.—This form of gleet has been described by Oberlaender as a pathological condition or inflammatory process, chiefly in the glands over the mucous lining of the cavernous urethra. The diagnosis of such a state can only be made by an ocular inspection with the urethroscope. Dr. G. T. Mundorf, of New York, has made a study of this disease, and written a paper that was published in the Medical Record, August 20, 1898. The treatment is made by electrolysis through the urethroscope in a similar manner as in strictures. The negative pole is used in the urethra, and the positive moist sponge-electrode applied over the abdomen. A galvanic battery must be chosen just the same as in the treatment of strictures.

It is best for the physician to stand to the right of the patient (the patient being seated in a reclining chair), for reason that the steps necessary to the operation can be followed more conveniently. The endoscopic tube is introduced to the bulbous portion of the urethra and then slowly withdrawn until a diseased glandular opening comes into view. The tube is now held steadily with the left hand, the sound is thrust directly into the opening of the duct, and the electric circuit is closed. In a few seconds, the following phenomenon is observed, showing that the electrolytic action is in play: A ring of grayish-white foam is seen to form around the electrode, somewhat obscuring the field of operation. At this stage it is best to disconnect the current, remove the electric needle, and then, by means of a cotton swab, dry the mucous membrane. The needle is not to be withdrawn from the tissues until the current has been disconnected at the battery, thereby avoiding a disagreeable shock. The operation can then be continued.

The strength of the galvanic current is about 4 milliamperes, and the current is applied to each affected gland for 30 seconds, or until the electrolytic action has produced the desired effect.

Not more than three glands should be electrolyzed during one session. Between the séances there should be an interval of 4 or 5 days. Mild urethral injections can be given 1 day after the operation. Endoscopic examinations should be made for the ocular inspection and operation.

GRANULAR URETHRITIS

115. This disease has a striking similarity with granulation of the eyelids. Electrolysis could be employed for the treatment, but the usual successful medication is a local application of the diseased foci through the urethroscope,* which we have practiced for many years. The following illustrations may explain the changes before and after the local application, which have been made from nature by an artist who had studied and graduated in a medical college. He made the sketches from nature, seeing them through the endoscope.

EXPLANATION OF FIGURES

In Fig. 27, (*a*) and (*b*) represent the same spot before and after the solution of nitrate of silver has been applied.

(*a*) represents the mucous lining of urethra altered by chronic disease, thickened, indurated, and of a dark, brownish color. Granulations are represented by the elevations and the darker color.

(*b*) is the same as (*a*). The solution has changed the color to a whitish gray, but the form is retained.

(*c*) and (*d*) represent the same place before and after the application of the solution.

In (*c*), the longitudinal fibers radiate from a center to the periphery, between which the granulations are distinctly seen, like strawberry eminences. The whole surface is intensely

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*R. Newman. "The Endoscope in Granular Urethritis in the Male." American Practitioner, August, 1871, Louisville.

Fenwick, "Electric Illumination." Churchill, London, has many references to the bibliography of endoscopy.

FIG. 27

inflamed and injected with blood. The structure is not altered as at (*a*).

(*d*) is the same place after the application of the solution with a glass-brush. The whole surface has now instantaneously changed to a pale, more normal, color.

(*e*) represents a part of the urethra restored to health by the treatment. Two months previous it looked exactly like (*c*).

(*f*) represents the last diseased spot in the urethra, 2 inches from meatus, to which the solution has been applied slightly. The color is now paler, as in health.

(*g*) represents a large inflamed surface in the urethra, ½ inch from meatus, deprived of its epithelium and covered with bloody exudation. In the middle is a depression—a loss of substance that suppurates.

(*h*) is the same place after the solution of nitrate of silver has been applied.

STRICTURE OF THE ESOPHAGUS

116. The treatment of *esophageal strictures* is almost the same as those of the urethra, and is mentioned here on account of that similarity. Successes have been achieved by electrolysis in cases in which other means had failed. Cutting-operations from below followed by gradual dilatation have been reported as successful, particularly by M. H. Richardson, of Boston, professor of surgery at Harvard Medical College. Gradual dilatation by bougies cures only in mild cases, but in constriction from pathological alterations must necessarily fail in the majority of cases. Professor H'Jorth, of Christiania, reported, at the International Medical Congress, in Copenhagen, a severe case in which the stricture had been caused by the patient swallowing an alkali. The contraction that followed was of such a nature that no sound would pass below the cricoid cartilage, and swallowing was nearly impossible. Gastrotomy was resorted to, and electrolysis applied at the part. The current was commenced with 5 milliamperes and gradually increased to 12. After 1 hour, the electrode suddenly passed through the stricture. After an interval of 12 days, a second

application of electrolysis was made, after which the patient could eat and swallow both solids and fluids, and a Charrière bougie, No. 19, passed through the former stricture both ways, from below and above. Two weeks later the gastric fistula was closed by operation.

As a rule the prognosis in esophageal stricture is grave. The elaborate statistics by M. Petit, of Paris, of 155 operations show only 2 per eent. of eures and 75 per cent. of deaths. Therefore, electrolysis in esophageal strictures must neccssarily play an important part in the treatment in the future. Other cures by electrolysis have been reported by various operators, as Prince, Butler, Dickman; E. T. Painter, Pittsburg, Pa.; D. S. Campbell, Detroit, Mich.; T. F. Frank.

117. Divisions.—Some authors divide esophageal strictures into differcnt divisions, whieh wc consider unnecessary, and which is confusing to the student. Among these divisions is the spasmodie stricture, which, for reasons alrcady stated, must be exeluded, because an occasional spasm is no stricture, and therefore no electrolysis is indicated. To another class, belong strictures of a malignant naturc, which are almost always hopeless. Electrieity may give a temporary relief, but a cure cannot be expected. The remaining subdivisions arc fibrous and eicatricial, which in reality means the same thing as a strieture caused by an inflammatory process, whether acute or chronic. By *organic stricture* is meant the class in which the electrolysis is indicated, and in most cases will be followed by a cure.

118. Etiology.—The etiology of strictures are usually of a traumatic nature, caused mostly by the swallowing of caustics, like lye, oxalic acid, eorrosive sublimate, etc., all of which eause a serious inflammation. If an obstruction is caused by the swallowing of a foreign body, like false teeth, which cannot be dislodged, nobody would think of applying eleetrolysis, and operative measures are indieated.

119. Diagnosis. — Diagnosis is made easily by the history of the ease and by an examination with a bougie,

which will be arrested at the seat of the stricture. Modern instruments, with electric light, will illuminate the stomach, and such an endoscopic examination may assist the diagnosis and treatment in some cases.

120. Instruments.—A galvanic battery described as suitable for the treatment of urethral strictures must be used, and firm, flexible electrodes of different sizes complete the armamentarium. Each size must be made in one solid continuity. It is very dangerous to have bulbs of different sizes that screw on one stem. No bulb that screws is safe, as it is liable to unscrew in time and drop, which new obstruction may cause the patient's death or at least necessitate a dangerous operation. For each size, a separate electrode must be made in one firm continuity. The bulb is egg-shaped, and soldered to one end of the wire; the other end of the wire is fastened to the metal that connects the cord to the negative pole of the

FIG. 28
Esophageal Electrode of Doctor Fort

battery. Around this wire another is wound spirally. The whole instrument is incased in a rubber tube, only leaving free the ends where the bulb and the connection for the battery are. We have devised a new improvement in which the central wire is omitted. Only a spiral wire is used, which makes the electrode more flexible and yielding. The length of the electrode should be 21 inches.

121. Modus Operandi.—The diagnosis has been made, the stricture found and measured, and the size of electrode necessary selected. If practicable, an ocular inspection with electric light might assist the diagnosis. Antiseptic measures can be used, particularly the atomizing of the mouth with a solution of boric acid or borolyptol. The patient is seated in a comfortable chair, so that he can bend his head backwards. The electrode selected for the operation and connected with the negative pole of the galvanic battery is introduced through the

mouth into the esophagus, if possible to the seat of the stricture. Then the patient takes the other electrode from the positive pole into the palm of his hand. This electrode may be carbon covered with felt or cotton and well moistened. Then the current is turned on from zero, cell by cell, to about 10 milliamperes. If the patient is not inconvenienced and the stricture is very dense, the current may be increased to 15 milliamperes. The operator holds the bulb against the stricture with ease and guides the electrode through the stricture and then into the stomach, in order to have the whole track well enlarged. Then the electrode is slowly withdrawn until the stricture has been passed, and the current is diminished again, cell by cell, to zero, when the electrode is entirely removed. During the operation the patient must control spasm and cough as best he can, and wipe off the saliva discharging from the mouth.

The séances can be repeated according to the tolerance of the patient, and the urgency of the symptoms. The duration is also dependent on circumstances, and may last from 3 to 20 minutes. Most patients cannot endure a longer period than 5 minutes. At each time, if possible, a larger sized electrode should be used. The operator must use good judgment and care, and be directed by the circumstances of the case and the tolerance of the patient.

We have had good results. Patients with stricture that could scarcely swallow milk or water were much improved and cured in a short time. In one case of very bad stricture, the patient after one application of electrolysis could drink well and did eat porridge of oatmeal; after the second application he could eat meat. The stricture was 13 inches from the teeth. The electrode passed and advanced to 15 inches. The electrodes must be made more flexible than the usual esophageal bougies made for gradual dilatation.

122. Electrocautery has been used in these strictures, and may succeed in some cases. However, it needs great care and experience, and should be made with the assistance of electric light for ocular observation. Strictures in other parts

of the body have been treated successfully by electrolysis. They may be enumerated as follows: Strictures of the female urethra and stenosis of os uteri; obstructions in the Eustachian tube, which often are the cause of deafness; strictures of the lacrimal duct, the nasal duct, and also anterior hypertrophies of the inferior turbinated bones. The treatment is similar to that described under urethral strictures; but details cannot be given here, as the diseases mentioned have already been treated.

STRICTURE OF THE RECTUM

123. This disease is very important, as it causes lots of anxiety, pain, and often increases so much that it is the real primary cause of death. In no instance has electrolysis achieved more successes than in this malady. Excluding such cases as have originated from malignant growths and syphilis, a cure can be promised and expected from electrolysis. Other means have too often failed, and a necessary colotomy is generally a torture and the beginning of the end.

Dr. George H. Rohé, of Baltimore, says:* "The treatment of stricture of the rectum by gradual dilatation or linear proctotomy is notoriously unsatisfactory. All surgeons admit the inefficiency of the first and the danger of the second. In electrolysis, we have a safe and apparently efficient method of treatment."

Dr. W. E. Steavenson writes:† "Strictures of the rectum can, like all other strictures, be treated by electricity. In the majority of cases there is no recontraction or return of the stricture, but, if due to cancer, a fresh growth of diseased tissue is very likely to take place, necessitating a recourse to the treatment. Successive applications of electricity are far better than the dernier resort of colotomy, and may keep the intestines patent as long as the disease allows the patient to live."

Endorsed by other equally eminent authorities, we emphatically join in recommending the adoption of electrolysis as *the*

*Atlanta Medical and Surgical Journal, July, 1888, page 297.

†"The Uses of Electrolysis in Surgery," by W. E. Steavenson, M. D.

treatment for rectal strictures. This opinion is further strengthened by experience and successes, some of which have been published.* We have successfully treated strictures of the rectum by electrolysis since March, 1871,† and, as the literature on this subject records no cases prior to 1871, we believe we are the originators of this method. The plan of treatment followed in those cases is almost identical with the method of treating urethral strictures by electrolysis.

124. Instruments.—The armamentarium consists of a good galvanic battery with conducting-cords, handles with sponge-electrodes (a few binding-screws), a set of rectal electrodes of different sizes and shapes, and a milliammeter to

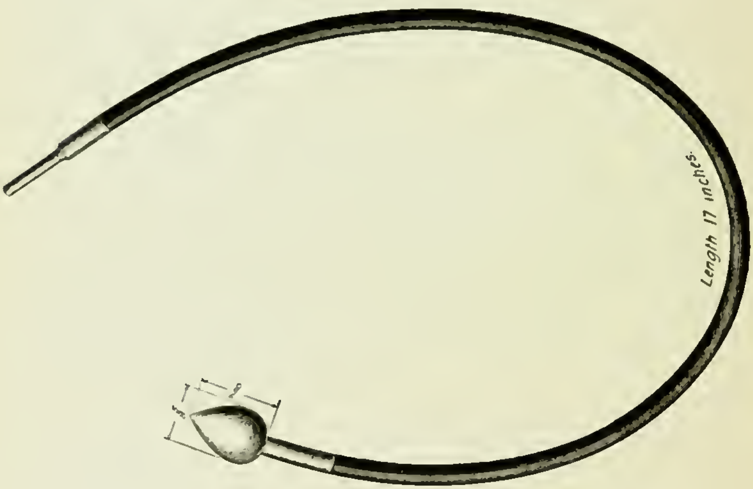

FIG. 29

Newman's Rectal Electrode

measure the electric current. The electrodes have at one end a metal bulb—copper or brass, silver- or nickel-plated. The form is flat or egg-shaped. They are made in sets of different sizes; the length is from $\frac{1}{4}$ to $1\frac{1}{4}$ inches, and the circumference from $1\frac{1}{8}$ to 3 inches. The stem of the electrode, except at the

*Journal American Medical Association, May 17, 1890.

†Specimen presented to New York Pathological Society, April 10, 1872. New York Medical Record, Vol. VII, 1872, page 208.

extremities, is insulated with hard or soft rubber; some are flexible, others stiff. If larger sizes are needed, a metallic bulb is used, similar in shape and size to vaginal electrodes, which are from 3 to 5 inches in circumference.

The best electrode (Fig. 29) for examination and treatment has recently been devised, which consists of a bulb on a spiral stem, insulated with a rubber covering. The instrument will accommodate itself to the flexures and easily enter the colon, thereby increasing the field of observation. Undue force is prevented; neither can the tube double up or turn on itself. If made long enough, it will enter into the transverse colon, where the bulb can be distinctly felt, and in some instances it can even be seen bulging out.

125. Modus Operandi.—The patient may be placed in the Sim's position, on the left side; but in the majority of cases the lithotomy position, on the back, is preferable, because in the examination and operation the anatomical relations of

FIG. 30
Doctor Fort's Rectal Electrolyseur

rectum and colon with the sigmoid flexure can be better appreciated. The galvanic battery is brought into action with the switch at zero. The sponge-electrode, wet with warm water and connected with the positive pole of the battery, is placed firmly in the palm of the patient's hand, but in some cases may be pressed on the abdomen or thigh. The negative metal electrode is lubricated with glycerin and inserted to the seat of the stricture, and then the electric current is slowly increased from zero until the desired strength is reached, which is ascertained mainly by the sensation of the patient. The strength of the current allowable varies from 5 to 15 or even 20 milliamperes, according to the seat of stricture, the nature of the neoplasm, the size of the electrode, and the susceptibility of the patient, the rule always being not to use a strong current if a

weak one will accomplish the object. The séance may last from 1 to 15 minutes. No force should be used; the electrode should be kept steadily against the stricture, and only guided; the electrolysis does the work of enlarging the caliber as the instrument passes the obstruction. At the end of the séance, the current is slowly reduced to zero, and not until then is the electrode to be removed.

It will be perceived that the occasionally stronger current in this operation is the only difference from the treatment of urethral strictures. Séances may be repeated in 1 or 2 weeks. According to circumstances and complications of the disease, some modifications of the treatment may be called for, one of which is the use of needles in the mass of the stricture instead of the metal bulb at the negative pole. The smaller electrodes are very flexible and long, the object being that undue force is impossible while being used. Some operators use stronger currents, particularly if anesthetics are used. Doctor Earle has used 50 to 100 milliamperes. We have witnessed an operation by Dr. W. F. Hutchinson where 39 milliamperes were well tolerated. If neoplasms are present, or carcinoma is suspected, stronger currents are indicated; they may be practiced under an anesthetic with needles in the same manner as in the treatment of tumors. Such are exceptions, and in carcinoma, an improvement and even a cure may be effected if the neoplasm is local and confined to a small area where the needles can destroy it.

126. Recapitulation.—In recapitulating the facts in these cases, we find some interesting items. It seems that females are more inclined to have rectal strictures than males. In 367 cases collected by Charles B. Ball, 276 were females and 91 males. In twelve cases observed by us only two were men. Their ages were mostly between 30 and 40 years, the youngest being 24 and the oldest 62. The two males were comparatively young men, being 23 and 26 years old, respectively. Eight cases were single strictures, and four were multiple strictures. The duration of the malady was from 6 months to 20 years. The causes varied, but hemorrhoids and constipation

TABULAR STATEMENT OF REPORTED CASES OF RECTAL STRICTURE

Cases	Sex	Age	Strictures			Cause and Complication	Result of Previous Treatment	Result of Electrolysis	Remarks and Sequels
			No.	Location	Duration				
1. M. V.	F.	24	1	2½ in.	6 mo.	Venereal; five fistulæ.	Dilatation; no success.	Cure.	Post-mortem specimen showed no relapse.
2. Mrs. D.	F.	62	1	4 in.	2 yr.	Constipation; atony.	Medical; no success.	Cure.	No relapse in 10 years.
3. Mrs. P.	F.	30	1	1½ in.	5 yr.	Syphilis; pelvic cellulitis.	Dilatation; proctotomy, etc.; relapse.	Cure.	Remained well, as long as heard from, for 10 years.
4. M. B.	F.	38	1	2½ in.	2 yr.	Hemorrhoids; constipation.	Operation; relapse.	Cure.	Not heard from.
5. Mrs. M. A. C.	F.	36	4	2, 3, 5¼, and 10 in.	5 yr.	Syphilis; malaria, tuberculosis.	Dilatation; relapse.	Improved.	Not heard from.
6. L. S.	F.	35	3	1¾, 3, and 5 in.	5 yr.	Constipation.	Proctotomy repeated; relapse.	Improved	Proctotomy; afterward used rectal bougies; relapse; died Oct., 1888.
7. R. B. A.	F.	43	2	5 and 10 in.	3 yr.	Membranous enteritis.		Cure.	Heard from; no relapse for 4 years.
8. G. E. W.	M.	23	1	3½ in.	1 yr.	Dysentery; suspected malignancy.	Failure.	Cure.	Well after 15 years; reexamined 1901.
9. J. M. R.	F.	46	1	1½ in.	10 yr.	Hemorrhoids; fissure.	Proctotomy; operation; relapse.	Cure.	Well; no relapse in 5 years.
10. E. M. B.	F.	44	2	3 and 5 in.	20 yr.	Hemorrhoids; constipation.	Operation; relapse.	Cure.	Well; no relapse in 1 year.
11. H. K.	M.	26	1	4 in.	1 yr.	Dysentery; proctitis, prolapsus, constipation.	Medical.	Cure.	Well; no relapse in 4 years.
12. B. L.	F.	30	1	2½ in.	3 yr.	Tumor of uncertain nature.		Cure.	Well; no relapse in 4 years.
13. S. T.[1]	F.	39	1	2 in.	4 yr.	Polypoid growths.	Dilatation failed.	Cure.	Well after 2 years.
14. H. W.[2]	F.	30	1	1 in.	7 yr.	Specific lesions; neoplasm.	Dilatation; proctotomy; failure.	Much improved	Well after 1 year.

[1] Case reported by Dr. S. Benton, London. [2] Case reported by Dr. S. T. Earle, Jr., Baltimore.

were important factors; other causes were syphilis, enteritis, and dysentery. It is certain that a rectal stricture may follow any inflammation of the rectum. One case was complicated by five fistulæ, commencing in the rectum and ending externally in different parts of the vulvar and gluteal regions. As soon as the stricture was cured, the fistulæ healed without any treatment; two had medical and the balance surgical treatment, six of which had been operated on with the knife. In not a single case had the previous treatment been successful; some were entire failures, and all that can be claimed in some exceptional instances was a temporary relief followed by relapses. Even the most sanguine operator will admit that proctotomy must be followed by the use of a rectal bougie at regular intervals. If we now compare all other methods with the treatment by electrolysis, we find that the latter has at least improved every case, and in the majority of cases has effected a cure.

Cases 5 and 6 were certainly improved, but in the end may not prove satisfactory; one patient had too many complications, and while we have not heard from her, we know she could not have been permanently benefited; the second case (No. 6) was an aggravated one, the patient being too poor to attend to herself, or even to come regularly for treatment. This case was then operated on, and she had to use a rectal bougie regularly, by which means the stricture was kept from closing up again; but after 4 years she had a relapse, with complications, and finally died. Case 8 is a perfect cure, and the patient remained well for 15 years, which fact has been graciously acknowledged by several surgical authorities; while a papillomatous growth, by some pronounced carcinoma, complicated the case to such a degree that a cure could scarcely be expected by any treatment. While two cases were improved, ten cases were cured by the electrolytic treatment, and, as far as known, no relapse has taken place, which were from 1 to 10 years, respectively, except one case, in which nothing has been heard from. The best results were achieved from the same method as used in the treatment of urethral strictures by electrolysis; that means by metal bulbs as negative, and weak currents in intervals. But

it is in the nature of the parts treated that the current can be applied stronger and oftener than in the urethra.

127. More recently we have operated on very severe cases with good results. Even in hopeless cases of carcinoma, the conditions were ameliorated and life prolonged. A former house physician of the Long Island College Hospital, later a well-known practitioner in New Hampshire, had a carcinomatous stricture of the rectum, and was so weak and emaciated that he could not leave his bed and had to have constant attendance. After treatment, he was so much improved that he went home, and in a letter stated that he was feeling well, had resumed practice, and on that day had walked 4 miles. A lady who had suffered ten cutting operations for carcinoma came from Italy to New York for treatment. Surgeons made the prognosis that she could not live 3 months. She was so much benefited by electrolysis, that she left again and traveled in Europe for 3 years. Of course, both these patients had relapses, and finally died. We by no means wish to give the impression that we cure carcinoma; these cases are only cited to show that electrolysis does good and even in carcinoma will benefit and prolong life. Constitutional diseases, as syphilis, must be treated by medicines and electrolysis may assist, as the case of Doctor Earle proves.

RECTAL DISEASES

128. Electrocautery and electrolysis have been recommended in various diseases of the rectum by different authors. Doctor Byrne, of Brooklyn, an expert and the inventor of an electrocautery battery, has practiced and recommends electrocautery and electrolysis as follows.

HEMORRHOIDAL TUMORS

129. *Hemorrhoidal tumors,* when isolated, may be clamped and removed with the cautery-knife, the incised stump or edges being subjected to extra cauterization before removing the clamp; and the latter should be allowed to

remain a few minutes after completing the excision, and its grasp released slowly and carefully, so as to avoid hemorrhage. When the tumors are large and occupy the whole or a greater part of the circumference of the anus, the manner of proceeding should be quite different. A wooden plug or clothes-pin, for example, or still better one of glass, $\frac{1}{2}$ to $\frac{3}{4}$ inch in diameter, with one or more circular depressions, is to be introduced into the rectum as a central point of resistance, and given in charge of an assistant. The loop, now made to embrace the entire mass, is to be very moderately tightened at first, and by an amount of heat, barely sufficient to bring this comparatively short length of wire to a cherry red, the operation is to be very slowly proceeded with until the glass or wooden core, as the case may be, has been reached. In the hands of Doctor Byrne, such an operation has usually occupied from 12 to 15 minutes.

RECTAL FISTULÆ

130. *Rectal fistulæ*, when blind or incomplete, may be treated first by passing a director through the canal to its bottom and incising with a cautery-knife; or second, in case the terminus of the channel should be near the surface, the director may be pushed through, a platinum wire passed, and grasped at either end by the forceps electrode. By a seesaw movement, the fistula can be laid open. The lining membrane of the fistulous tract should then be cauterized in its entire length and the wound packed. The slough will become loosened in 3 or 4 days, when the part should be irrigated and otherwise treated in the usual manner; but there will be no necessity for further packing, as in a case operated on in the ordinary way.

HEMORRHOIDS

131. *Hemorrhoids* have also been treated in different ways, either by the electrocautery or by electrolysis with a metallic working electrode, or with one or two needles. The pole must be selected according to indications. Different methods are used for the operation, and either may be correct, according to

the appearance and location of the hemorrhoids. If an absorption is desired, the negative pole is used; if the tumor is vascular and the intention is to seal up the vessels, the positive pole must be selected. Needles may be used, the selection of the pole being made according to the effect wanted. Sometimes two needles may be inserted into the pile, each being connected with one pole of the galvanic battery. It is best to treat each hemorrhoidal tumor separately. The current may be 10 to 20 milliamperes strong for 10 to 15 minutes. In some instances it is best to remove the tumor with the electrocautery-écraseur. This operation must be done slowly, in order to avoid hemorrhage and close the vessels by the effect of the heated wire. Acute cases that are very painful should not be operated on.

The operation should be preceded by an evacuation of the bowels, and before the operation a cleansing irrigation and possible antiseptic measures should be taken. An anesthetic is not necessary, but the injection of a solution of cocain into each pile to be operated on is desirable. Ocular inspection can be made by the insertion of a speculum. The current should remain closed until the parts change color to a whitish gray, which may be expected within 4 minutes. The electrolytic action results in an absorption. After the séance it will be well to give an opiate as an anodyne and partly to prevent a passage of the bowels for a few days, in order to give a better chance for the healing of the parts. Surgical operations have been successful, and the injection of carbolic acid in a diluted solution has often effected a cure.

CONSTIPATION

132. The daily natural evacuation of the bowels is often interfered with by dietetic errors, but mostly becomes chronic by habitual neglect; and the valves of the intestines will be quasi-paralyzed, non-acting, and the mucous lining loses its tonicity. Cathartics may relieve temporarily, but will not cure the constipation, nor restore the tonicity of the parts. In these chronic cases, electricity will do wonders; and applied

persistently, must cure most cases. Sparks from the static machine, applied for the tonic effect on the liver, pancreas, and intestines, will stimulate these organs to action, but the best treatment is galvanism with small pad-electrodes. Two ways of application are advised. Place the positive pole either over the epigastrium or over the region of the liver. The other electrode, as the negative pole, is slowly moved by a rocking advance in the direction of the peristaltic motion, which is beginning in the right inguinal region, going upwards on the ascending colon, then from right to left over the transverse colon, and downwards on the left side over the descending colon. This must be done slowly, and several rounds made in the same way. From the end of that circle in the left inguinal region the pad must be pushed to the right side without raising it from the cuticle, in order not to cause a shock by interrupting the current. The duration of the séance is about 12 minutes, the current being arranged to the tolerance of the patient, which is about 20 to 25 milliamperes. Three applications should be made every week.

If a stronger effect is desired, a pole in the shape of a round rectal electrode—a small vaginal electrode will do—can be inserted into the rectum. Generally, the positive pole is indicated, but there may be symptoms present that make the negative pole desirable. A careful physician may combine with the electric treatment, medicines and a systematic use of enemas.

PROLAPSUS ANI

133. *Prolapsus ani* is best treated by the employment of the high-tension current from the faradic apparatus. The positive pole is at the prolapsed part; the negative over the abdomen, or may be held in the palm of the hand. The current is given with rapid interruptions, as an induced current with the whole coil, the arms being on the first and seventh buttons. Poles may be changed at times. The current is employed at zero and gradually increased to a strength suitable to the tolerance of the patient. Repetitions are given three times a week.

FISSURES OF THE ANUS

134. French electrotherapeutists, particularly Doumer, have treated this ailment successfully by the high-frequency current. One electrode is inserted through the anus, and the current given for about 7 minutes. Repetitions are made until a cure is effected. The usual surgical treatment consists in laying the parts at rest by forcible stretching of the sphincter, which has to be done only once, and in many instances is preferable.

DISEASES OF THE TESTICLE

HYDROCELE

135. The object for a cure is the evacuation or absorption of the fluid and exciting an inflammation within the sac for the adhesion of the walls of the cavity. Cures by single or repeated applications of electrolysis have been reported by Althaus, Rudolfi, Erhardt, and Bartholow. The principal method recommended consists in evacuating the fluid, then introducing two needles into the tunica vaginalis, where the electrolytic action is carried on. The needles must not touch each other, nor the testicles or the cord. Variations of this method may be made. Sometimes only one needle from the negative pole is used, the positive pole being held on the abdomen. Failures take place just as well as with other means.

ORCHITIS AND EPIDIDYMITIS

136. The electric treatment given in these diseases is the galvanic current, either to the scrotum or, as Lewandowski recommends, directly over the cord. The parts are very painful, and great care is needed in handling and supporting them. The pads should be placed on either side of the affected parts, with the galvanic battery at zero. The current should be very gradually increased to 5 milliamperes, and just as gradually decreased to zero; the poles should then be reversed, and the current again increased and decreased. The poles may be

reversed in this way several times. Daily applications are necessary. The pain may also be allayed by local applications of the wave-current from the static machine. The wave-current has been recently introduced, and is given by a piece of block tin from the positive pole of the static machine applied close to the cutaneous surface of the part affected by pain.

INFLAMMATION OF SEMINAL VESICLES

137. Each *seminal vesicle* may be called a part or a reservoir of the vas deferens. Its diseases are mostly acute and a tubercular disease, which often is a sequel of a chronic inflammation. External and internal remedies are employed. The electric treatment of the inflammation consists in employing the galvanic current in the following manner: The positive pole, in the shape of a pad-electrode, is placed on the lumbar region, and the negative pole is applied through the rectum to the seminal vesicle. This negative pole may be made of metal, like brass, German silver, or copper, insulated on one side, so that the electrolytic effect is on the vesicle. A small vaginal electrode may also be used for the negative pole. Only a weak current should be given—about 4 milliamperes—for a period not longer than 5 minutes. The application must not be repeated too soon—the interval should be 5 days. Dr. W. B. Snow has recently devised for this purpose an electrode of metal. This electrode has a hollow groove, so that it can be adapted to the vesicle and also to the convex surface of the prostrate gland. He used it for applying the wave-current and reports marked success in cases of prostatitis.

SPERMATORRHEA

138. Definition.—According to the derivation of the word, *spermatorrhea* means the unnatural ejaculation of semen that contains spermatozoa. This disease is very rare, and usually patients who come for treatment for spermatorrhea have only pollutions, either nocturnal or diurnal, in which an electric treatment may be advisable. Occasional emissions in long

intervals need scarcely any treatment, as the cause may be an overflow, an extra sexual excitement, or a sexual abstinence from the regular habit. However, if the emissions are frequent, so that the patient's health gets impaired, it will be a neurological lesion and treatment is imperative.

139. Etiology, Etc.—This disease is mostly the consequence of masturbation, sexual excesses, mental strain, or overwork, or the sequel of inflammations of organs like the prostate, seminal vesicles, urethra, or cord. The diagnosis is made from the history of the case, the abnormal condition of the patient, and from the examination. The prognosis differs according to the case and circumstances, but is generally favorable. The treatment consists of general dietetic and hygienic measures, tonics, anodynes, rest, and the cessation of all bad habits.

140. The electric applications are nearly the same as those advised for the inflammation of the seminal vesicle. According to theory, the sedative action of the positive pole should be expected to be employed, but the practical experience is that a mild electrolytic action of the negative pole has had the best results. The positive pad-electrode is applied over the spine or the lumbar plexus; the negative pole is directed through the urethra with either a Newman's egg-shaped electrode or with a metal electrode per rectum to the seat of the disease. A current of 3 to 5 milliamperes from a galvanic battery is used for a short time—3 to 5 minutes—once or twice a week. To ameliorate the irritable condition of the affected parts, a high-tension current can be employed from the long fine-wire coil of the faradic apparatus. Local galvanic applications with pad-electrodes may be given over the spine with a descending current, if the spine needs a stimulation, as general tonic breezes or sparks of the static machine will improve the general state of the patient materially.

If the disease is real spermatorrhea, that means an often-repeated emission of seminal fluid with spermatozoa, it is generally due to a prolonged gonorrheal discharge, which has extended posteriorly to the vesicle. The openings of the ducts

are enlarged and weakened, which causes the emissions. Under such circumstances, the object is to give power to the ducts and contract their openings, which is effected by the contractile power of the high-tension current from the faradic apparatus. Another method would be to use Newman's electrocautery-sound. The distance to the ducts has to be measured with the introduction of a flexible cathode and marked on the catheter as soon as the urine begins to flow. This distance, in most cases, 7½ inches, is marked on the electrocautery-sound, which instrument is then introduced into the urethra. The instrument has been previously connected with a secondary battery, and when the cautery-wire has reached the affected part, two or three sparks are given in rapid succession by pressing down the handle. These sparks must not cauterize, and the effect must be only stimulating and astringent, in the same manner as Lellemand intended his applications with the nitrate-of-silver stick.

ASPERMATISM

141. *Aspermatism* is rare, a kind of sterility of the male, with a sexual appetite and power, but without an ejaculation. There may be nocturnal emissions and lascivious dreams. It seems this disease is not sufficiently understood, but appears to be a nervous affection. The indication is to apply the galvanic current over the spinal cord from the ligamentum nuchæ to the perineum as a descending current over the parts mentioned, or in sections thereof. Treatment may be given every other day and the current increased to the tolerance of the patient, stimulation of the cranial nerves being avoided and the strength of the current diminished as soon as a coppery taste is manifested.

URETERS

142. *Ureters* convey the urine from the kidneys to the bladder, and may be affected by continuation of the diseases of these organs. If they are injured by traumatism, the repair must be attended by the surgeon. Obstructions by calculi occur, which need medical or surgical aid, and electricity cannot

do any good. In the diagnosis of this condition, catheterization of the ureters is of utmost importance. The electric light illuminates the field under observation. There may be many obstacles to the success of an ureter catheterization. It needs an expert operator and a good ureter cystoscope, which is being gradually improved and perfected.

DISEASES OF THE BLADDER

INCONTINENCE OF URINE

143. Electrotherapeutic applications of various kinds have been advised, which sometimes cure and in other cases utterly fail. Considering the different causes of incontinence that often is only a symptom of the malady of other organs, this uncertainty of effect is explained; and this chapter is introduced for the purpose of a *caveat* to the electrotherapeutist. If a patient cannot control micturition, by which the urine dribbles away as an overflow, it may be caused by diseases of other organs, as the rectum, prostate, urethra, or bladder, or a paresis local or originated in the spine, thereby acting as a reflex, or a nervous disease from depression or excitement.

According to the cause, the remedy must be selected, and that explains the advice of text-books and report of successes, and the different methods advised. If the cause is a general nervous depression or neurasthenia, perhaps the static application will do best; it should be given as a static breeze to the spine and over the lumbar region, and then, if the patient can tolerate it, sparks can be withdrawn from the patient on the platform. Benedikt, of Vienna, advises sparks to the hypogastric region and along the spine. Morton and others use the static machine and a pistol-shaped electrode direct to the bladder and perineum. In some cases, particularly in spinal diseases, galvanization of the spine as a descending current will do well. In simple nervous and paretic diseases, local faradization is indicated. If the bladder itself is affected or the contractile power of the walls is weakened, an insulated sound (except 3 inches at the conical end) is introduced into the bladder as the

negative pole, while a pad-electrode is placed over the region of the bladder. The current must be mild—5 to 6 milliamperes for about 5 minutes. Any electric application for this malady should be given as weak currents and for short terms, from 4 to 5 minutes at a séance. Another excellent method is to use hydrogalvanism, as formerly explained, to electrify the water injected into the bladder. It may be difficult to select the correct method, but the physician has to exercise good judgment, firstly to make a correct diagnosis, and secondly to select the treatment indicated, and pursue it systematically with reason.

ENURESIS IN CHILDREN

144. *Enuresis in children* is in reality a nocturnal incontinence, which has been described very well by Dr. Mary Putnam Jacobi. According to causation, galvanism or faradism is advised. Steavenson has had successes with galvanism.

145. Electricity in Incontinence of Urine.—Capriati (Edinburgh Medical Journal) records a case of involuntary enuresis successfully treated by means of the currents introduced into medicine by Morton, of New York. These are known as induced static currents, and are furnished by the oscillatory discharge of Leyden jars connected with an electrical machine. The patient is not insulated, but is connected with one of the jars, while the other is connected with the earth. The intensity of the current is regulated by merely altering the distance between the discharge-rods. Capriati's patient was a previously healthy man of 35, who was gradually attacked by weakness and wasting in the left leg, with clubfoot, and exaggerated knee-jerk on that side. There was no reaction of degeneration, but incontinence of urine was very troublesome. The author considered the symptoms to point to limited lesion of the spinal cord in the lumbar region. After several experiments with different currents, Morton's currents were used in conjunction with the spinoperineal galvanization. Immediate relief followed, and after the treatment had been carried out every other day for 2 months, cure was complete as regards incontinence.

VESICAL AND URETERAL CALCULI

146. An early diagnosis, which can be made by the employment of the Roentgen rays, is important. These calculi have been dissolved in the laboratory by electrolysis, but in the human body they needed a stronger current than is practicable. Therefore, electric treatment has been abandoned.

VESICAL SPASM

147. *Vesical spasm*, or *vesical tenesmus*, which some medical authors, by tradition, have called a "spasmodic stricture," may arise from different causes, and is often only a symptom of other diseases. If the sphincter vesicæ is thrown into spasmodic action, a retention of the urine follows. To reverse this order, it may be stated that the retention of the urine causes vesical spasm, and the question arises, Which of the two states is cause or consequence? Winckel enumerates the causes of vesical spasm as (1) neuralgia of the bladder, (2) excitements from sexual excesses or onanism, (3) colds, etc. Other causes may be sitting on cold stones or ground in damp weather, and drinking new beer, which is sold as lager beer. All urethral obstruction causes more or less retention of urine, which may be followed by spasm. Paralysis of the bladder itself, or of the spinal nerves leading or governing the action of the bladder, must necessarily cause spasm of the bladder. Paralysis of the bladder proper arises mostly from distention of the walls of the organ by the urine, which stretches the muscular coat to such a degree that the power necessary for expelling the urine is impaired or lost.

Both the galvanic and faradic currents have been successfully used in spasm of the bladder, and either may be correct, according to the cause of the spasmodic action and indications. Dr. Ernest Wende, of Buffalo, reports a case treated by galvanism as follows:*

"E. B., a strong, healthy looking young fellow, aged 25, consulted Doctor Hoddick of this city, about a year ago, for a

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*Buffalo Medical and Surgical Journal, December, 1890.

supposed deep stricture of the urethra. He gave a history of having had gonorrhea on several occasions, followed by the usual methods of treatment. One year prior to this, while in the city of Rochester, he was suddenly seized with an attack of retention.

"He immediately consulted a local physician, who advised and practiced electrolysis of the urethra, with a result that proved almost disastrous, for the symptoms that ensued became so urgent, the febrile disturbance so marked, that his parents were sent for. Subsequent to the consultation with Doctor Hoddick he again experienced retention, which the doctor succeeded in relieving by the administration of the usual hip-baths, morphin, suppositories, etc. He then left town for a few months, but on his return he was again seized with a similar attack. Once more the doctor was summoned, but on this occasion all antispasmodic and antiphlogistic treatment failed, nor could the accumulation of urine be drawn off by means of the catheter. However, the patient was finally relieved by aspirating the bladder per rectum.

"A few days later, at the suggestion of Doctor Hoddick, I was invited to see the case. On instituting an examination, we encountered no difficulty in passing a number of sounds, and therefore concluded that the trouble was merely spasmodic.

"Some months later the patient called me up at midnight, saying that he could not find Doctor Hoddick, and that he had just returned from Erie. He walked into my office in a stooped manner and appeared restless. He referred to pain and local uneasiness in the lower part of the abdomen. His expression was anxious, and his desire for relief urgent. He had not been able to void his urine since the previous evening. He furthermore stated that the retention was occasioned by an attack of diarrhea.

"My first thought was to employ an anesthetic and careful catheterism, when it suddenly occured to me that the pathological significance of the reflex irritation in its bearing on retention might be relieved by electricity. This I found to be true by placing one electrode, the positive, on the perineum,

the other, the negative, above the pubis, over the bladder. The current employed was the galvanic, the dosage 20 milliamperes, and the length of application 5 minutes.

"Immediately, the urethral spasm became supplemented by a copious flow of urine, of a dark color and a strong odor. The patient immediately experienced a sense of relief and exclamations of joy were frequently uttered during the process of micturition. It was a grateful mitigation of an urgent desire. It was a gratifying result. Doctor Hoddick has since had an opportunity to confirm the value of this plan of treatment."

148. Dr. H. B. Stanley, of San Miquel, Cal., used faradism and reports as follows:* "Spasmodic stricture is usually caused by irritation of the urethral canal, excessive venery, sudden cold or chill to the perineum or fundament, or some nervous irritation to the lumbar or pelvic plexus of nerves. Unless relieved, it may last for days or weeks, and from being a local disease its effects may become apparent in the whole system, especially the nervous system. Spasmodic stricture may also be caused by acrid and vitiated urine. One of the worst cases of spasmodic stricture I ever saw was caused by the urine being loaded with uric acid. A week's treatment with appropriate internal remedies completely cured him, and there has been no return of the disease since, some three years ago. Immediate relief, however, was given by the use of faradic electricity, the patient holding one pole in his hand and the other being applied to a silver catheter inserted as far as possible into the urethra. When convenient, I used a urethral sound insulated to the point, which was armed with an olive-shaped bulb prepared expressly for the purpose. Usually, a treatment of 2 minutes relieved the spasmodic condition and the patient could void the urine copiously."

149. Organic stricture is an entirely different disease and requires a widely different treatment.

From these two different treatments, the lesson may be that the physician must use that current which is indicated from the

*Summary, March, 1901.

correct diagnosis made and the real cause of the spasm. Any obstruction to the flow of urine must be overcome or removed, urine passed, and the bladder irrigated with a hot, antiseptic, anodyne solution. If it is doubtful that the catheter will enter the bladder, irrigation may be made by gravity with a siphon arrangement and hydrogalvanism. In violent spasm, the attempt to enter the bladder with a metal electrode by galvanism may fail and even aggravate the contractions, and in most cases the faradic current from a high-tension coil will succeed best. A sound-electrode, as the positive pole, is introduced into the urethra and a pad, as the negative pole, is placed over the lumbar region; the current is then slowly increased until the electrode sound or catheter passes into the bladder. The induced current is preferable with a long coil of fine wire. Sometimes one electrode in the rectum may do best. The rapid vibrator is preferable. If the cause of the spasm is a general or central paralysis, two pad-electrodes should be placed over the spine, as a descending galvanic current, or the anode over the lumbar regions and the cathode over the bladder above the symphysis pubes. About 8 to 12 milliamperes may be given for about 10 minutes. If the muscle of the bladder has lost its contractile power, the hydrogalvanization is indicated. In nervous diseases, the external application of the high-tension faradization should be used. The local use of the faradic current to the spine is mostly contraindicated in nervous patients.

CYSTITIS

150. *Cystitis* is very painful with acute tenesmus, and causes a heavy feeling above the pubes, as of a weight pressing downward inside the bladder. The late Dr. W. F. Hutchinson has been successful in relieving the symptoms of pain and tenesmus, and describes his treatment as follows: "Place the patient recumbent, a flat sponge-electrode under the sacrum, and a carbon electrode and pad to the perineum. Through the tissues then in circuit cause a current from twenty low-tension cells to pass steadily for 10 minutes, gradually lessening the number of cells to zero. It is surprising how quickly pain has

vanished and tenesmus lessened under this treatment," etc. If other means and therapeutics in the treatment of cystitis are preferable to electricity, it must be left for the decision of the attending physician in each individual case.

TUMORS OF THE BLADDER

151. Electricity has done much to make the treatment of *tumors of the bladder* more successful than the means formerly employed. A cystoscope is necessary to make the diagnosis and follow the progress of the treatment with ocular inspection. An improved instrument of Bierhoff would permit the introduction of instruments for treatments, which however is not absolutely necessary.

Tumors may be treated by electrocautery for the removal of the tumor, wholly or in part, by degrees. We will illustrate the method employed by us. Our applications were made in such a manner that the patients were not detained from business or pleasure, but came to the office for treatment and went home after the séance, sometimes necessitating travel by rail. Most patients were females, but the principles employed can also be used in males. The only difference in treating males consists in having the instruments made a little longer, to comply with the anatomical differencc of the urethra. Only non-malignant tumors were treated in the manner described. These tumors of the bladder have been described by many authorities and to repeat here is unnecessary. Recently, a most excellent paper on this subject has been written by John B. Hamilton,* M. D., LL. D., which is a concise essay, almost exhausting the subject and giving much information. The authors cited are Stein, Thompson, Tuffier, Ricard and Bousquet, Watson, Southan, Dittal, Wallace, Perragaux, Jewett, Norton, Guyon, Berling, Spauton, and Kelly. We find in this paper a very good classification of non-malignant tumors by Barling—the history, etiology, pathology, symptoms, diagnosis, treatment, and statistic tables. The treatment described is sur-

*Journal of American Medical Association, May 20, 1893, page 553.

gical, but not a word is said about the use of electricity. Hence, all that can be found in the literature on the subject is omitted here, and only the methods of electricity and the instruments used by us, which are considered new, will be described.

The tumors that appear in the bladder are of different character, as enumerated by Barling, Goulson, and others. Tumors that came under our observation were mostly papillomata, myomata, and vascular (angiectasia venosa).

152. Diagnosis.—The malady is suspected by certain symptoms, as pain, irritability, frequent micturition, chills, insomnia, general malaise, hematuria in intervals, sudden retention, the abnormal state of the urine, etc. However, a diagnosis can only be made with certainty by ocular inspection of the bladder. This is made by the cystoscope and endoscope. The cystoscope of Leiter is illuminated by a storage-battery, and if successful the experienced operator will see the tumor—rather a little magnified—as plainly as in good, bright daylight. The cystoscope will not always be successful, but when it reveals the tumor the diagnosis is a certainty. To verify such a diagnosis made, we also use the old Desormeaux endoscope immediately after the cystoscopic examination. If the same condition is seen as found before by the cystoscope, the location of the tumor is verified by an exact measure—how far it is situated from the meatus and how far it is to the right or left of the median line. If such a measure is taken carefully, embodied in the notes of the case, the tumor can be found again with any instrument to be employed hereafter.

We have successfully used the endoscope of Desormeaux in diseases of the urethra and bladder since 1866. In examination, it shows the parts as they really exist at the end of the endoscopic tube. The part of the bladder immediately beneath the tube can be treated with the solutions generally used; other places may be reached by changing the tube to other focus. The advantages of the cystoscope are that it gives a better light, magnifies the parts, and the whole bladder can be explored, giving at once a larger field in loco; but it serves only as a means of diagnosis. The management of either appliance needs some

practice. So far we have had the best results, and were enabled to make a positive diagnosis by employing both the cystoscope and the endoscope in succession, as also before and after using electrolysis. Other examinations for diagnostic purposes are made by exploring the bladder with a bougie à boule, or a sound, and by injection or irrigations of the bladder, in order to find the capacity of the viscus, the state of the walls, its mucous linings, abnormal contractions, and the sensibility of the patient.

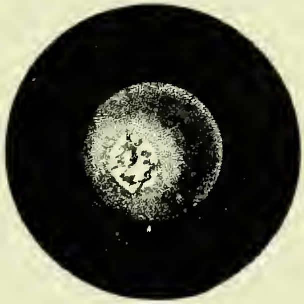

FIG. 31
Myomatous Tumor

153. Varieties of Tumors. Benign tumors in the bladder may be of different varieties, as mentioned in the text-books. Fig. 31 represents a myomatous tumor, springing from the muscular wall of the bladder, raised and standing on a wide base like an acorn-shaped body, sensitive and painful on touch but does not bleed.

Fig. 32 represents an angiectasia venosa, a chain of varix, of a dark-blue color, extending like a chain of berries in a line,

FIG. 32
Angiectasia Venosa (Before Treatment)

FIG. 33
Angiectasia Venosa (After Treatment)

of irregularities, stretching on the fundus of the bladder, $1\frac{1}{2}$ inches above the neck, in a transverse direction. The tumor was painful, irritable to the touch, and bled only a little at certain intervals.

Fig. 33 represents the same tumor as Fig. 32, as it appeared after it had been treated a few times by electrolysis, showing a similar change as can be observed in a nævus after electrolysis has been used.

The tumors have been eured by clectrolysis per urethram and therefore pathological and microscopical specimens could not be procured.

154. Treatment.—Coneomitant with electrolysis, or as a preparatory treatment, measures are employed to make the patient comfortable. To allay pain, anodynes are given—best in the form of rectal suppositories and external galvanization. The tone of the bladder must be restored, and the troublesome spasms conquered. Medicated injections and washing out and irrigating the bladder suceeed so well that the viscus will soon tolerate from 12 to 16 ounces, when formerly it could hold searecly 4 ounees.

155. Electrocautery will do good service in removing the tumor by degrees. After the tumor is well located, the electro-eautery-instrument is marked by a ring in such a manner that, after introduetion, the platinum wire will cover the tumor in the bladder when that part of the instrument marked by a rubber ring appears at the meatus. Then, the fenestra containing the platinum wire is pressed downward against the tumor, and by pressing the current-breaker a few times on a screw, the platinum wire is instantaneously heated from a storage-battery. The instrument is almost identieal to our electrocautery-sound, and only differs in being shorter and almost straight at the end. The two poles run inside an insulated tube, so that nothing will be heated but the platinum wire situated in the fenestra.

We have never failed to electrocauterize the exact place wanted, whieh fact was verified by an oeular inspeetion with the eystoseope. However, if there should be any doubt about the exact situation, the operation can be done with the place to be operated on fixated while the bladder is illuminated with the cystoscope. In the same manner, an electrocautery-sling may be used to remove a tumor at the pedicle.

156. Electrolysis may be used in different ways, but under all circumstances a galvanic battery is necessary, no other will do; or, in other words, the constant current of a galvanic battery is imperative. As a rule, the negative pole is applied to the affected part. The positive pole, in the shape of a pad or a covered carbon, is held to the palm of the hand or pressed externally over the suprapubic region. Each séance may last from 5 to 15 minutes, as indicated by method and circumstances. The strength of the current is from 5 to 20 milliamperes, an average of 10 milliamperes. The intervals of séances are governed by the result of each operation and by the condition of the patient. The first step in the modus operandi is to draw off the urine, which can be done with the urethral glass speculum, which is a very useful auxiliary, as will be shown later. If necessary, the bladder is washed out through the same glass speculum, and at least 4 to 6 ounces of clear water are left in the bladder. This water may contain a little table salt or bicarbonate soda, which facilitates the electrolytic action. In most electrolytic operations in the bladder, it is of great importance to have the bladder filled with water, and when the cystoscope is introduced, the water is needed to keep the electric lamp cool. Without the water the lamp would burn the mucous lining. After these preliminaries, each electrode is applied in its place and the electrolytic action begins, the current being gradually increased from zero to the desired strength.

157. Different Methods of Electrolysis.—There are principally two methods, general and localized.

1. *General Electrolysis.* — General electrolysis is accomplished by holding the electrode bulb in the water that fills the bladder, without touching the tumor. The electrode, Fig. 34 (*a*), is insulated except at its extremities. One extremity has an olive-shaped metal bulb, which is introduced as the negative pole per urethra into the bladder and held beneath the water without touching the tumor. The positive pole, in the shape of a pad, is held in the hand or on any cutaneous surface, which completes the circuit. Then the current from a galvanic

battery is slowly and gradually increased to the desired strength and the electrolytic work begins—from the water to the tumor. It is surprising what good effect this general electrolysis has on the tumor and general condition of the patient. It allays pain at once, makes the patient more comfortable, and has a specific, absorbing, and healing effect on the tumor. The latter effect is slow but steady.

Other advantages of this method are, that it can be done often, in fact almost daily, or in the intervals between other localized operations, which saves time and encourages the patient, who never complains of any pain during such séance. When tumors were almost removed, but a vestige left, which scarcely could be reached locally without encroaching on the

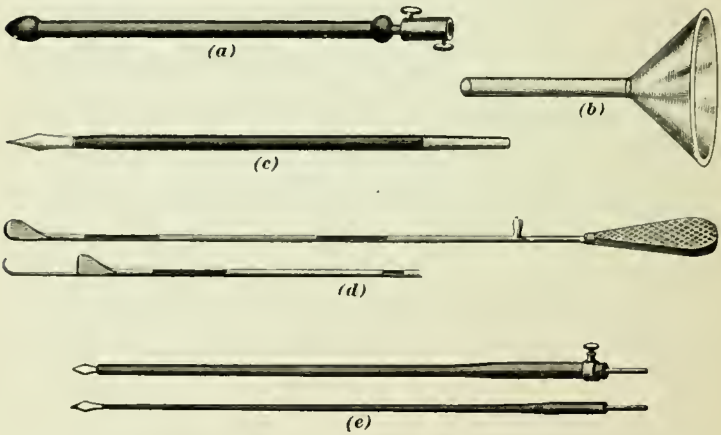

Fig. 34

sound tissue, this method of general electrolysis did such good service that the case was finally cured.

2. *Local Electrolysis.*—This is accomplished by pressing the negative pole against the tumor or penetrating the same, as follows: (*a*) electrode metal bulb in contact with tumor; (*b*) platinum needle in tumor; (*c*) fixation of tumor and platinum needle in tumor; (*d*) cannulated platinum needle direct in tumor with or without fixation. Here we have four

methods, from which one can be selected according to indications and the work to be done.

(*a*) The same electrode as described in general electrolysis is also used for this method. The only difference from the former is that the metal bulb is held against some part of the tumor and in contact with it. After a certain time, when the electrolysis has acted enough in one place, the point of the electrode may be moved to another part of the tumor and changed successively to different parts.

(*b*) This and the two following methods are made on the same principle as the electrolytic treatment of a nævus. The negative needle is introduced into the tumor and then the electrolytic action absorbs or destroys it. This electrolyzed portion shrivels, contracts, and heals, by degrees, until a healthy surface appears. The urethral glass speculum, Fig. 34 (*b*), is introduced so far into the urethra that its end is near the entrance of the bladder. Into the speculum, the platinum needle, Fig. 34 (*c*), is so far advanced, that its end is near the opening of the speculum. Then, with a quick movement, both speculum and needle are pushed into the bladder, and at the same moment the needle is pushed forwards, to be left in the bladder, while the speculum is removed without discharging the water left in the bladder. Then the needle is pierced into a part of the tumor and the electrolysis used as before. Sometimes it is a little uncertain where and how deep the needle passes, and in such doubt another method may be practiced. However, an operator who has had sufficient experience will overcome such uncertainties, and, if necessary, he can see the action and location of the needle by using at the same time the cystoscope, which has been done.

(*c*) This and the next method are nearly the same in principle as the last. The only difference is a greater certainty in the location of the needle by a new instrument devised by us—the vesical tenaculum cache, Fig. 34 (*d*). This tenaculum is protected at the end by a safeguard that can be moved, and thereby leaves the tenaculum free and exposed. This tenaculum runs in a very slender stem, which, when in the urethra, occupies little space and permits other instruments to pass

alongside at the same time. The tenaculum is introduced closed; when in the bladder the safeguard is withdrawn, and the tumor fixated and held firmly by the tenaculum. Then, if the safeguard is pushed forward, the tenaculum cannot disengage itself from the tumor and has a steady hold on it. If there is any doubt about the location of the tumor, the cystoscope can be introduced alongside of the tenaculum and the latter can be seen and guided into the exact location desired. Then the cystoscope is removed and the needle introduced into the tumor, the stem of the tenaculum acting as a guide. Electrolysis is applied, the instruments removed, and, if desired, the parts may be inspected again with the cystoscope.

(*d*) For this method, another new instrument is used—the cannulated needle electrode, Fig. 34 (*e*). The needle inside the cannula is fastened by the screw at such a place that the sharp point is covered by the cannula. Then the cannula is introduced in the bladder, its open end pressed against the tumor, and at the same time the needle is pushed forwards as far as it can go. The screw is then fastened again. In this position, the needle fills out the cannula so firmly that no water can escape from the bladder and the point of the needle projects out of the cannula scarcely more than $\frac{1}{8}$ inch. If the needle is now forcibly pushed into the tumor, it cannot penetrate farther than $\frac{1}{8}$ inch, and therefore cannot do any harm. If it is desirable, either the tenaculum or the cystoscope may be used at the same time. However, there is scarcely a necessity for doing so, as we always found the exact spot to be penetrated, which was verified by a subsequent inspection with the cystoscope. This instrument proved to be invaluable for diagnosis and treatment in these cases.

The new instruments here demonstrated have contributed greatly to the success of the operation. These instruments have been devised by us as necessity required. In most cases, it will be necessary to use both local and general electrolysis, the method to be selected according to indications.

158. Conclusions.—The following conclusions have been derived from what has been said in regard to treatment of

tumors of the bladder: (1) Tumors in the bladder of the male can be treated by electrolysis, but in most cases it will be preferable to perform suprapubic cystotomy and remove the tumor by electrocautery, electrolysis, or the knife for a radical cure. (2) A galvanic battery only must be used. (3) All operations have been made per urethram without any assistant, anesthetic, pain, or detention from business, coming and going as they pleased. (4) The result has been very satisfactory, patients acknowledging a cure, and in some cases reliable physicians having made an examination and pronounced the patient cured. (5) While the result has been favorable, it is not asserted that electrolysis will cure all benign tumors of the bladder.

DISEASES OF THE PROSTATE

159. The *prostate* is a musculoglandular organ situated at the posterior part of the urethra, lying in front of the neck of the bladder. Its physiological function is to secrete a fluid, which forms a part of the ejaculated semen, and is therefore very important in coition and fecundation. Its function is wholly sexual. The diseases of the prostate are described as atrophy, congestion, abscess, calculi, follicular prostatitis, neuralgia, gonorrheal prostatitis, prostatitis, and hypertrophy. For a practical consideration in the present subject only the last three need our special attention.

GONORRHEAL PROSTATITIS

160. This is a complication of posterior urethritis. The gonorrheal inflammation extends from the anterior to the posterior urethra, and in many cases this extension is caused by the treatment, and mostly by the injudicious use of strong, irritant injections. In such cases, the application of a solution of argonin may do good and free the parts of the gonococci; then local application to diseased parts through the urethroscope will improve the mucous linings; and, lastly, high-frequency currents may be given with a metal sound introduced

into the diseased part. Lately, several apparatus for high-tension, high-frequency currents have been invented. A metal sound, insulated except 3 inches of the lower extremity, may be applied to the diseased prostate, the other electrode, as a pad, being held in the palm of the hand or over the region of the bladder and then high-tension currents given.

PROSTATITIS

161. *Prostatitis* may appear at any time in life, but occurs generally in young men or in those of middle age. It is an inflammation that has progressed from an acute to a chronic stage. It may result from sexual excesses and sexual perversion, particularly masturbation, unskilful use of the catheter, violence, the use of caustics, or of strong injections in the deep urethra, and as a result of gonorrhea. The principal symptoms are soreness and severe pain extending in all directions. This pain is of a dull, aching character, which is aggravated by the touch of any instrument inserted for the purpose of investigation or treatment. It is referred to the perineum, rectum, urethra, and bladder, even to the suprapubic region and the pelvis. Urination causes scalding, and coition and ejaculation are so painful that intercourse is made almost impossible. Epithelium appears in the urine as flocculi or thin shreds. Hypermia of the parts can be seen on endoscopic examination, which often causes bleeding. Complications occur in adjacent parts, and manifestations of a general neurasthenia may ensue.

162. The treatment should first be directed toward allaying pain and irritation before radical measures for cure can be commenced. Irrigations of hot water, simple or medicated, are very important. It is best to use a siphon-arrangement with a nozzle not longer than 1 or 2 inches. The water-receptacle should be placed sufficiently high, so that the fluid will be propelled by gravity, and thus no instrument will be in contact with or irritate the hyperemic portion. Anodyne suppositories should be employed, and ointment of a similar kind should be

injected into the urethra. Benzoinol with cocain deserves particular mention. When the painful irritation has subsided, we have often effected a cure by local galvanization. The electrode must be introduced with great gentleness and must not be pushed onward while contact with the prostate gland gives rise to pain. The galvanic current must be mild, from 3 to 5 milliamperes. The electrode in the urethra should be connected with the negative pole, while the positive pad-electrode is held by the patient. Sometimes it may be well to begin with high-tension currents as an analgesic. We object to the local application of nitrate of silver, which generally over-stimulates the parts and thereby makes matters worse. Any treatment requires time, care, and patience on the part of the surgeon and the patient, and if such is exercised the result will be a cure. Hygienic measures and rest must be insisted on. Surgical interference has been recommended, the consideration of which must be omitted here on account of limited space.

HYPERTROPHY OF THE PROSTATE

163. *Hypertrophy of the prostate* differs from prostatitis in that it is a disease of advanced age and is not painful. The prostate is scarcely sensitive to the touch. The enlargement acts as a mechanical obstruction to the bladder, which prevents a free flow of urine. Cystitis develops with dilatation of the muscular walls of the bladder and causes frequent micturition and often retention. Other sequels of the obstruction to the passage of urine are ureteritis, with dilatation of the ureters, pyelitis, and pyelonephritis.

The enlarged prostate obstructs the free flow of urine. Its action is mechanical. The mechanical obstruction to the free flow of urine causes dilatation of the bladder and ureters, congestion of the neck of the bladder, and frequent micturition. To produce the other complications of enlarged prostate, namely, cystitis, ureteritis, pyelitis, and pyelonephritis, infection is absolutely necessary. The cause of these latter complications in the great majority of cases is the introduction of pyogenic organisms by the catheter. In making electrical

applications to the prostate, therefore, aseptic surgical technique should be rigorously observed. A large majority of these sufferers succumb prematurely.

No rational treatment has thus far been adopted for the cure of this disease. Volumes have been written on the subject. Various methods have been suggested for the amelioration of the trouble, and for the allaying of actual pain. Cases have been reported as cured, either by injections, destruction, incision, enucleation, or prostatotomy, etc., but no successful method of cure has yet been determined.

164. The great importance of establishing a method for the *radical* cure of the enlarged prostate no one can gainsay. The physician must make a correct diagnosis, and select the remedy from the different methods, which have been employed and which will be here explained. The electric treatment, according to the currents used, may be subdivided as follows:

(*a*) *Electrocautery.*—(1) The slow method of flashes by Newman's electrocautery-sound. (2) Bottini's method in one séance. (3) Modifications of Bottini's operation. (4) The radical cure by operation—cystotomy—and the removal of the hypertrophy by electrocautery.

(*b*) *Electrolysis.*—(1) Electrolysis by mild currents per urethra or per rectum. (2) Massey's operation per urethra and rectum with strong currents. (3) Electropuncture per rectum.

(*c*) *Static Applications.*—Wave-current per rectum.

(*d*) *Cataphoresis.*—By Iodin. For years the author has applied the electrocautery-sound by rapid flashes without creating a cauterization.

ELECTROCAUTERY

165. Newman's Electrocautery-Sound.—This instrument was presented and demonstrated at the Ninth International Congress held in Washington, D. C. The electrocautery-sound, Fig. 35, is a catheter-shaped instrument with a short curve at one end, and is made of smooth, polished metal. Near the tip of the curved end is a fenestra in which is placed the platinum wire

that constitutes the burner. A serpentine form is best for this wire; each end is firmly attached to one of the two copper rods inside the tube *h* and represent, respectively, the positive and negative poles. The other end of the instrument is straight and forms the handle, in which commence the copper rods, each of which is fastened to one of the pins or heat-conductors *d* and *d'*. These two pins are connected with two electric cords by binding-screws. The other ends of the two electric cords are fastened, respectively, to the positive and negative poles of the battery. The current-breaker *b* is movable, and when set straight and pressed firmly down to the screw *c* the current is closed and the burner *e* instantaneously heated.

The improvements consist in (1) having the handle in one light, convenient piece; (2) having the current-breaker under the immediate control of the index finger; (3) having the

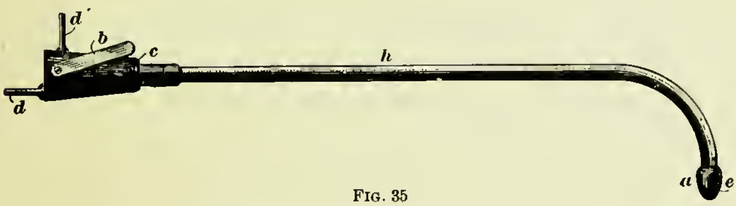

FIG. 35

Newman's Electrocautery-Sound

a, Fenestra, Inside of Which is the Burner. e, Platinum Wire. h, Tube. d and d', Pins to be Connected With the Electrode Cords. b. Current-Breaker. c, Screw to be Connected With Current-Breaker b

fenestra filled up, whereby the instrument is more thoroughly insulated and less liable to become heated; (4) having the tube filled up, thus preventing it from getting wet or blocked with débris inside.

Any good storage-battery or electrocautery-battery constructed to give a certain amperage can be used. The strength of the current should be determined with a rheostat before every operation. The heat must be of a high, red color, just short of white heat, the instant the current-breaker is touched; this heat must be kept while the wire is in contact with the mucous lining.

166. It is a mistaken idea of many that the electrocautery necessarily burns, destroys, and is followed by cicatricial tissue. This is a favorite objection made by those not acquainted with the use of electric currents. If the operator bungles or wishes to destroy, he can, but the expert will not.

It is well known that eminent neurologists apply the electrocautery directly to the faces of young ladies without even causing marks. All depends on the manner of application. Even deeper applications on mucous linings may cauterize, without destroying. Voltolini, Carl Michel, Shurley, and Yemans of Detroit, and many others, have applied the cautery to the nasal and pharyngeal cavities with great success. Therefore, it is evident that different methods can be instituted with the instrument and applied for various purposes to different parts.

167. Application to the Enlarged Prostate.—Patients suffer more or less from this disease. They may be perambulant or in bed, or may divide their time between bed and room; the hypertrophy may be small or extend to the size of an egg, or even an orange. Complications and pain may be beyond endurance to the sufferers. According to the state and circumstances the treatment must be selected and the method applied.

The slow (regular) method, which has done good service, consists in giving the enlarged gland only a short application, from an instant to 3 seconds' duration. This causes nothing more than a white film similar to the effect of nitrate of silver, in the treatment of Desormeaux.

168. Modus Operandi.—The instrument is connected with the electrode wires, which are then attached to the battery, having all the apparatus in perfect order. When all is ready, try the instrument with a short flash, which experiment excludes any possible failure. The prostatic portion to which the cautery is to be applied must have been examined, and the distance from the meatus measured. This distance is then marked on the instrument by a small rubber band. The patient, according to his preference, may stand erect, be on an

operating table, or in bed. The instrument is then introduced, so that the fenestra with its platinum wire is in contact with the part to be cauterized. The operator will know by touch when the instrument is in the right place, and the measure will corroborate the correctness of the observation. One hand holds the instrument and then touches the little spring to connect the interrupter, a flash follows, and the finger disconnects the current. In one moment, the operation is done and the instrument is withdrawn.

It causes no pain, and in some instances the patient scarcely believes that anything has been done. He is able to walk about and is not detained from business. The séance should be repeated in about 3 days, or even in 2. The instrument must be kept scrupulously clean, as the cautery will fail, if there is dirt between the connections.

169. The question now arises, How does this method bring about a cure? The end sought is, first to remove the obstruction so that the bladder can discharge all the urine at regular intervals, and then, in order to make the cure radical, to reduce the prostate to its normal size. The theory is that the cautery first acts as a tonic and next as an astringent; the diseased mucous lining shrivels, the glandular tissue contracts, and, by shrinkage, the size is diminished. The stimulation gives new life and healthy action. Each repetition of the operation acts similarly and perhaps on another part of the hypertrophy. The operation must be continued until the cure is effected. Care must be taken not to overstimulate and cause prostatorrhea, acute prostatitis, etc., thereby creating or aggravating the very ailment we seek to cure. The cautery must be given just severely enough to accomplish the object and no more. If the cauterization is too prolonged and too deep, the glandular action is overtaxed and weakened and will be followed by a prostatorrhea, which takes a long time to cure. At the same time, an inflammation is created, which causes pain and swelling, and, at last, the too greatly cauterized tissue will slough.

The advantages of the electrocautery over the knife are: (1)

that it avoids hemorrhage, also secondary hemorrhage; (2) it leaves no raw surfaces exposed; (3) it heals better; and (4) it avoids infection. The statement of some reports, that in prostatotomy with the knife hemorrhage does not take place cannot be accepted, as the history of cases shows that primary as well as secondary hemorrhage does occur, both of which are entirely avoided with electrocautery. In treatment of the enlarged prostate by electrocautery, it is absolutely necessary to pay attention to other symptoms and troubles of the patient, according to established principles. Pain must be allayed. The bowels must be kept regular, since constipation adds considerably to the inflammation and, by pressure, causes pain. While the electrocautery process is used it is of the greatest importance to attend to the state of the bladder, by drawing off the urine, and irrigating if necessary.

170. Bottini's Operation.—The originator of this method has successfully operated upon many hundreds of cases and kept them modestly to himself, only once in a while giving a report in Italian medical journals. This operation is a rapid electrocautery with a platinum burner in one séance. It consists in burning a passage through the enlarged gland by the electrocautery, thus enlarging the passage and removing the obstruction. The burner is made of heavy platinum encased in an instrument resembling a lithotrite. The burner is heated until red, or even hotter, by an electric current from a storage-battery, and by a screw it is slowly advanced through the obstruction. Antiseptic precautions are advisable, particularly of the bladder. It is still a mooted question whether the bladder should be dilated with air or water. A local anesthetic to the prostate portion of the urethra is absolutely necessary, cocain being preferable. Some patients may choose ether narcosis. Several incisions forward and backward may be made if the operator finds such a procedure necessary.

171. Attracted by the first reports of this operation, we performed it several times. The late Doctor Guleke, of New York, had imported an original Bottini instrument with which we operated. These operations were performed in 1882 and

1883, but were not satisfactory. This fact explains the incorrect statements of recent reports in 1897 and 1898 to the effect that the Bottini operation had never been performed in this country. Not having had the expected result with the Bottini instrument, we constructed the electrocautery-sound just described. While the genius of Bottini is appreciated and admired, his first instruments were not perfect, particularly in the points as follows:

1. The instrument was clumsy, unhandy, and heavy.

2. The platinum burner was so thick that it got hot too slowly and, when hot, lost its shape by bending so that sometimes it would not move back into its beak.

3. The very large storage-battery was too heavy for transportation and a smaller one did not generate enough heat.

4. The instrument was shaped like Heurteloup's lithotrite, the ends having only a short coudée. Such an instrument is exceedingly difficult to introduce, and in many cases of hypertrophy non-introducible, the mechanical obstruction leaving no space for its passage. The intention is to push the instrument into the bladder over and beyond the enlargement of the prostate, then to reverse it so that the beak is turned downward. The electrocautery-knife is hidden inside the beak and moves outward when the dial is turned on the handle as the battery heats it, thereby making a central cut in the obstructing prostate.

5. The result of this operation was very uncertain. It sometimes caused shock, pain, and inflammation and irritated the bladder, and the exfoliation of the scabs caused by the cautery gave rise to more complications. It may be again stated that the effect of the electrocautery is really a burning through the tissues, being entirely different from electrolysis, which is a chemical absorption.

6. The patient had to remain in bed for weeks, and from some reports made by Bottini himself it has been shown that voluntary micturition occurred only after 24 days.

7. The operation is not free from danger.

These objections refer only to the old original instruments. Recent modifications have been made.

172. Modifications of Bottini's Instruments.—A modification of Bottini's apparatus was made by Freudenberg, of Berlin. This device, Fig. 36, is a great improvement and does away with some of the objections experienced in former times. Freudenberg describes his modification as follows: "The modifications in point are relative to shape, handiness, and electrotechnical construction, affording at the same time the possibility of sterilization. The modified instrument is provided with a stout cylindrical, grooved handle, strong and steady in the hand, resembling the well-known handle of a lithotrite. The cooling-apparatus is inserted on this side of the handle instead of at its farther extremity, thereby obviating incandescence of the handle and securing the rubber hose of the cooling-apparatus from being compressed by the ulnar aspect of the hand. In lieu of the platinum blade, platiniridium is used, this alloy being harder and less apt to bend by reason of its electrical resistance, permitting the employment of the weaker current for rendering the blade incandescent. Another addition consists in the conduction of the current, ascending to the knife, within the guide through a single wire only, which equals in volume the two wires used in the original instrument; the descending current passes through the hull proper, and by reason of its close contact with the cannula, through the entire length of the external instrument. Moreover, greater steadiness of the blade, riveted as it is to the inflexible hull, is assured.

Fig. 36

"The connection of the instrument with the conducting-wires has been achieved by a process corresponding with the axis of the instrument and leaving both poles in a concentric arrangement. A slight jerk will move up the corresponding cable-attachment to which the

cables are fastened; these are united to one conducting-wire, and owing to the improvement of electrical construction are much thinner than formerly."

173. The operation of Bottini has been described as "one of detail." This is undoubtedly true, yet from a practical point of view it is just as true to state that it is an operation of a few important factors. These factors are: (1) The condition of the bladder, whether empty or containing a certain quantity of liquid or air. (2) The length, depth, and number of incisions. (3) The complications that have been brought on by the enlarged prostate or by previous efforts to remedy the enlarged prostate gland. (4) Reliable working-apparatus.

Bottini's first operations were performed on a bladder filled with liquid. Later, he operated on an empty bladder, because he thought the liquid in the bladder interfered with the heating of the cautery-incisor. At the present time, the operation is always performed on a bladder containing either liquid (usually a sterilized solution of boric acid) or air. Bransford Lewis recommends the injection of air into the bladder. Lewin-Goldschmidt has pointed out, as a result of experiments on animals, that in injecting air into the bladder there exists the possibility of an air-embolus entering the ureter and reaching the heart through the renal veins and inferior vena cava. Freudenberg reports 43 operations on bladders containing air with no untoward results so far as injecting air was concerned.

At the present time, no one operates on an empty bladder, the viscus containing either air or a solution of sterilized boric acid. The possibility of an air-embolus entering the ureter should have considerable weight with the operator, particularly as there is no such complication to be expected when using the sterilized boric acid. With the modern sources of electric supply, the objection made by Bottini, when using liquid in the bladder, is no longer tenable. The cautery-incisor can now be maintained at the required degree of heat during the passage through the prostate gland. In operating on an empty bladder, Freudenberg cut through a transverse fold of the fundus of the bladder. Some operators claim that the burning sensation

experienced by patients during the operation is due to the heating of the sterilized solution of boric acid by the cautery-incisor.

174. Length, Depth, and Number of Incisions. The cautery-incision or incisions constitute the pivotal point in every Bottini operation. They constitute the raison d'être of the operation. Whether the operation shall be repeated or not depends entirely on the dimensions and number of the incisions. To make a posterior incision too short means an unsuccessful operation and carries with it the necessity of repeating the procedure at some subsequent date. To make a posterior incision too long means an internal urethrotomy through the floor of the membranous urethra with its well-known sequences as a result. Three incisions are generally made, one posteriorly and one on each side. The posterior incision is by far the most important. The success of the operation depends in a large measure on the posterior incision. If successfully executed, it lowers the level of the bladder drainage, the prostatic urethra to the level of the base of the bladder, and permits a free flow of urine through the furrow produced by the cautery-incisor. It secures a direct route for the urine, from the center of the bladder through the anterior urethra. This posterior incision, and also the lateral incisions, diminishes the blood-supply to the prostate and therefore causes atrophy. Another effect of these cautery-incisions is to prevent recurrent congestions of the neck of the bladder that mean so much in the life of every prostatic.

The anterior incision is never employed unless cystoscopy shows the mechanical obstruction to exist in the anterior aspect of the urethra. The anterior incision is dangerous. The liability to cut into the cavum Retzii with its consequences should be remembered when making an anterior incision. The depth of the incision will depend on the height of the incisor and the pressure exerted on the prostate gland. The average height of the knife used by Freudenberg is 1.2 centimeters. The sizes of his knives vary from .8 to 1.5 centimeters. The height of the knife of American instruments averages from 1.2 to 1.5 centimeters. A difference of a few millimeters in the height of a knife can be fully compensated for in the depth

of the incisions by pressure made on the gland by the operator. In determining the depth of the incision, the operator studies the configuration of the prostate gland by means of the cystoscope and also by rectal examination. If necessary, the knife is made to pass twice through the same area in the prostate gland, and during both incisions it should be maintained at a white heat. With one knife of average height maintained at white heat and passed twice through the same area of prostate tissue while pressure is being exerted, the operator can give his incision the required depth.

175. The length of the incision will depend a great deal on the nature of the enlargement, whether it is fibrous or glandular. A fibrous enlargement is slightly compressible; a glandular one is very much so. As a rule, the length of the posterior incision in fibrous prostates should correspond to the difference between the normal urethra and the pathological one under treatment. If the urethra in question measures 28 centimeters, we know the normal urethra measures 21 centimeters, and the length of the incision should be the difference, or 7 centimeters. When the length of the incision is determined by rectal examination, 1 or 1.5 centimeters should be added to the longitudinal diameter of the prostate. Freudenberg has not yet found it necessary to make incisions larger than 5 centimeters. His new instruments are arranged to permit of an incision 6.6 centimeters long. When glandular elements predominate in the prostatic enlargement, the conditions are entirely changed. Glandular enlargements are very compressible. When the beak of the incisor begins to press on the gland, the longitudinal diameter begins to decrease at the same time. Willy Meyer, M. D., has pointed out that the simple means of measuring the length of the prostate in his cases is of little assistance in determining the length of the incision necessary in a given operation.

The same author now uses an incisor that permits of incisions as long as 8 centimeters and recommends long incisions under the following conditions: (1) When the enlargement is fibrous and pronounced, so that the upper border of the gland

cannot be reached or palpated per rectum. (2) Whenever there is a median lobe of some size present. (3) Whenever the length of the urethra has been found to be materially beyond normal.

When the prostate is soft and compressible, he recommends short incisions, not longer than 1 to 2 centimeters. It is better in cases of soft, compressible glands to make an incision too short, rather than to take risks in making one too long. In this latter case, the pars membranaeea would be incised, followed by urinary infiltration with its accompanying dangers. In determining the length and depth and number of incisions in the prostate gland, the operator should use every means of informing himself on the diameters, configuration, and consistency of the gland. He should make a thorough examination per urethra and per rectum. Unless contraindicated, the cystoscope should be used.

176. The Bottini operation is suitable for all forms of prostatic hypertrophy. An enlarged prostate is an impediment to the passage of urine, and a cautery-incisor will cut its way through this impediment, whether hard or soft and whether situated posteriorly, anteriorly, or laterally. It is of little importance, also, whether the bulgings or prominences are toward the bladder or exclusively toward the urethra.

The results of the Bottini operation, however, in any form of prostatic hypertrophy will depend on the condition of the bladder and kidneys and on the general physical condition of the patient. The better the condition of the bladder and kidneys, the better will be the results of operation. The results of the operation will be negative when the bladder is hopelessly damaged and when there is a general atheromatous condition of the blood-vessels associated with polyuria.* In prostatic hypertrophy, the earlier the operation is performed, the greater are the chances of a permanent cure. Convalescence in these cases is very rapid, and the results obtained so far as can be ascertained at present are permanent.

*Orville Horwitz, B. S., M. D., Philadelphia Medical Journal, June 22, 1902.

Willy Meyer, M. D.,* recommends that the Bottini operation be done when it becomes necessary to give the catheter into the hand of the patient himself. This is the period at which the real danger of life begins. A single introduction of the catheter may set up incurable cystitis, pyelitis, or pyelonephritis. Bottini's operation, according to the same authority, is not absolutely contraindicated by the existence of pyelitis. In two cases operated on by him, a marked degree of pyelitis was present. Both patients stood the operation nicely, one being cured and the other much improved. The fact of the existence of an infected genito-urinary tract should render the operator very cautious in his prognosis in these cases.

177. Armamentarium.—If the physician provides himself with a transformer, a good rheostat, and ampere-meter, the commercial circuits may be used as sources of electric supply. When the commercial circuits are not available, a good storage-battery must be employed. The storage-battery should give from 50 to 60 amperes with an electromotive force of 4 volts. For care and management of storage-batteries, see *Electrophysics*, Sec. 1. Freudenberg added the ampere-meter to the armamentarium of Bottini. The flow of the cautery-current is noiseless; therefore, the necessity of an ampere-meter to designate the current-strength during the operation is obvious. The current-strength necessary to bring the cautery-incisor to the required heat should be determined before each operation. When the cautery-incisor is at a white heat, envelop it in a few layers of absorbent cotton saturated with water and observe the effects both on the incisor and the needle of the ampere-meter. This is a useful experiment and renders visible to the operator what takes place when the incisor is traversing the tissues of the prostate.

178. With a single charge of a storage-battery, Freudenberg performed six operations. Storage-batteries, even when not used, run down and require charging every 3 or 4 weeks. It is a good rule to recharge the battery before each operation.

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*Willy Meyer, M. D., Medical Record, April 28, 1900.

Two or three operations may be done on the same day with the same charge, but if a few days intervene between operations, recharging the battery will always be the safest procedure. The operator should examine the Bottini incisor and all its connections before the operation, in order to be sure that everything is in good working order before commencing to operate. As some accident may happen to the incisor either immediately before or during the operation, the advantage of having two cautery-incisors will be readily appreciated. Besides the source of electric supply and the Bottini incisor with its connections, the operator will always need hand-syringes, catheters, local anesthetics, and antiseptics.

In the operation of Bottini, the practical genito-urinary surgeon will be occupied a great deal with the electrical apparatus; the practical electrotherapeutist, already familiar with the management and control of electric currents, will be most occupied with the technique of genito-urinary operations. A nice combination of these two acquirements—familiarity with the technique of genito-urinary operations and familiarity with the management and control of electric currents—are necessary for the best execution of Bottini's operation, and therefore the best results obtainable.

179. Complications During and After Operation. The complications during the operation are the bending of the cautery-incisor, perforation of the bladder, and perforation of the membranous urethra. In order to prevent bending of the cautery-incisor, the operation should be done slowly and the index finger should be removed from the rectum when the beak of the incisor is properly located and before the cautery-current is turned on. The patient should be cautioned to keep absolutely quiet during the operation. If the Bottini incisor is not held firmly and steadily in the left hand of the operator, bending of the cautery is liable to occur. The means of avoiding bending of the cautery-incisor are slow operation with the cautery-blade at white heat and immobility on the part of the patient. The incisor is held firmly and steadily in the hand of the operator.

The liability of perforating the membranous urethra is greatest in glandular enlargement of the prostate. A short incision is required in these cases. A careful study of the longitudinal diameter of the gland and of the nature of the prostatic enlargement, whether glandular or fibrous, will be the best safeguard against perforating the membranous urethra. If the incision is made too short, the operation may be repeated at a future date. Since operation on an empty bladder has been discarded perforation of the bladder has not occurred. If the beak of the incisor is properly fixed behind the prostate, it will press the bladder downward from the cautery-blade. This precaution joined with the condition of the bladder, distended with liquid or air, will make perforation of the bladder an extremely rare accident.

The complications after the operation are hemorrhage, sepsis, and retention of urine. The prevention and treatment of these complications belong to general genito-urinary work and will not be described here. No one should attempt to perform the Bottini operation unless he is familiar with the best methods of preventing the occurrence of these complications and of treating them when established. The operation of Bottini, even in favorable cases, is a serious procedure. The patient should be thoroughly prepared for the operation by the observance on the part of the operator of all precautions of modern surgery.

180. Anesthesia.—The majority of operators employ local anesthesia. If it becomes necessary to give a general anesthetic, nitrous-oxide gas is used.*

Orville Horwitz, B. S., M. D., in a series of articles recently published,† gives the following conclusions as the results of his experience in 34 Bottini operations:

1. There is less fear on the part of the patient to submit to operation than there is to any other surgical procedure so far suggested for the relief of prostatic hypertrophy.

2. The principal advantages to be derived from the method

*Ramon Guiteras, M. D., New York Medical Journal, April 29, 1899.

† Philadelphia Medical Journal, June 8 and November 30, 1901.

of treatment are: A short time only is required to perform the operation, which is attended with little shock and usually slight loss of blood; convalescence is rapid; and the mortality is lower than that by any other radical measure.

3. Cures result in a large majority of cases, especially if the operation is undertaken early. Marked improvement may be looked for in a vast number of cases where otherwise individuals would be condemned to suffer, as the danger attending any of the other radical methods of treatment would be too great to warrant their employment.

4. Failures occur in but a comparatively small percentage of cases, want of success being due to pathological changes and complications that have taken place. Especially is this true in those instances where an incurable cystitis exists.

5. The operation is contraindicated when a valve-like formation exists, or where there is a greatly increased overgrowth of the three lobes associated with tumor formation, giving rise to a pouch above and below the neck of the bladder.

6. It may be employed with benefit and safety as a palliative measure in cases of prostatic hypertrophy of long standing associated with cystitis, when the general health will be improved and constipation, which is usually associated with this condition, relieved, mitigating the prostatic spasm of the urethra and rendering the insertion of the catheter easy and painless.

7. Pyelitis, when present, adds greatly to the danger of the operation, but is not always a contraindication to its employment.

8. The character of the growth has but little bearing on the result of the operation.

9. The operation may be employed as a safe and satisfactory means of causing a suprapubic fistula to close, which so frequently follows a suprapubic cystotomy when the prostate gland is hypertrophied.

10. In suitable cases, it is not only the best radical measure thus far devised for the relief of prostatic hypertrophy, but is attended by the smallest mortality.

11. The operation is especially indicated in the beginning of obstructive symptoms due to hypertrophy of the prostate gland and may be regarded as a prophylactic method of treatment.

12. The operation is capable of producing a symptomatic cure in a great number of cases of various conditions and configurations of the prostate gland due to hypertrophy, as is shown by the disappearance of prostatic spasm, the restoration of the function of the bladder to its normal condition, and the improvement of general health.

13. When operating early, before the prostate has become much enlarged, the safest method to pursue is to perform a preliminary perineal cystotomy, introducing the perineal electro-cautery-incisor of Chetwood, so as to make the incision in the prostate.

14. In some instances, a prolonged preparatory treatment is necessary before the operation can be safely undertaken.

15. In cases of prostatic obstruction, which have existed for a lengthened period, where there is chronic cystitis and the physical condition of the patient being below par, both local and constitutional treatment must be persisted in for months after the operation before the great benefit derived from the procedure can be insured, which treatment would be ineffectual unless the obstruction had first been removed.

181. Newman's modifications of Bottini's instrument has been constructed for reasons stated, as a simpler and handier

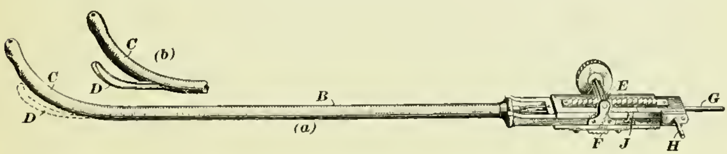

FIG. 37

Newman's Modification of Bottini's Incisor

apparatus, than the modification of Freudenberg, which is very good, timely, and rectifies some of the objections mentioned.

Fig. 37 (a) shows the instrument in perspective, with platinum burner, shown in dotted lines, slightly exposed. (b) is the end of the instrument with the platinum knife fully exposed. The instrument consists of a hollow metal shaft B, terminating in Thompson's curve with tunneled end C. The platinum

knife D is propelled backwards and forwards by means of a rack and pinion E. Two insulated copper wires pass through the shaft and carry the electric current to the platinum burner. The conducting-cords from the battery or commercial circuit are adjusted to the instrument at staples G and H. The current may be thrown on or off by means of the switch F. A scale and indicator J shows at a glance the extent to which the knife is exposed. Freudenberg's improvement on the original Bottini are very good and were needed. On this improved instrument, the writer has made the following modifications, as shown in the cut:

1. Omitting the water-cooler, in order to make the mechanism of the instrument simpler. The water-cooler is an impediment, takes up space, and needs for its proper management a special assistant. As the burner is smaller than in the original instrument, it does not need so much heat, and this can be controlled more easily. It has been questioned whether it is better to dilate the bladder with water or air. Each method has its own advantages and objections.

2. It is better to do away with the heat of the instrument. This is accomplished by the two conducting-wires conveying the heat, which are attached one to either end of the burner and which run separately, being insulated. This arrangement will heat the burner immediately and prevent the heating of any other part of the instrument. The shaft remains cool.

3. The end of the instrument is conical and of a smaller size, in order to pass any obstruction and enter the bladder more easily. Thus, the operation can be performed in cases in which the larger-sized portion of the instrument could not be introduced.

4. There is a tunnel at the conical end for a filiform guide, over which the instrument passes, to be used at the option of the operator.

5. The iridoplatinum burner is thinner and stationary, and thereby cannot get out of shape and place, and, besides, the greater heat is avoided.

6. The protector of the burner, when moved, acts at the same time as a meter, the operator thereby knowing the exact

situation of the burner. This burner, or knife, can cut to any depth, as the operator desires, and by rotating can cut in different directions. The instrument can be taken apart for cleaning and sterilization.

7. This instrument is cheaper and costs about one-half as much as the original Bottini or the one modified by Freudenberg.

182. Radical Measures, Combination of Operation and Electrocautery.—This consists in the removal of the hypertrophy by electrocautery in situ and in one operation, access being gained by either perineal section or laparotomy. This removal may be partial or entire, and can be done with the electrocautery-burner or wire loop. This operation is indicated, in fact, we may say peremptorily demanded, when the patient is in immediate danger of succumbing and no time is left for a slower method of procedure. This state has arrived when the hypertrophy causes absolute retention of urine and there is no possibility of gaining an entrance through the obstruction so as to evacuate the bladder. Complications have generally taken place and the fatal end is within a few hours, either by rupture of the bladder or urethra. The radical operation proposed for such a state is not free from danger, but as the patient without it will succumb in a short time, the operation cannot decrease his chances of recovery.

The improvements in the technique or suprapubic cystotomy by Belfield, Hunter McGuire, Kuemmel, Morris, and others have reduced any danger to a minimum. Mr. A. F. McGill, of Leeds, in opening a discussion at the Section of Surgery, British Medical Association, August 16, 1889, remarked that suprapubic prostatectomy was preferable to a urethral or perineal operation. The urethral operation was unsatisfactory; it was founded on the faulty anatomy, for in only 4 out of 24 cases he had tabulated was there anything resembling a bar at the neck of the bladder. The suprapubic operation was also more generally applicable; in only 3 of the 24 cases in his table could the perineal operation have been done. He also considered the suprapubic operation more safe than perineal section. Most authorities will agree with Mr. McGill.

ELECTROLYSIS

183. Electrolysis With Weak Currents.—Electrolysis has been used with favorable results, and cases reported accordingly. We have practiced it in the same manner as in strictures of the urethra and often applied a flat metal-electrode as negative pole per rectum against the prostate. With great care and very mild currents, good results followed. Dr. W. E. Steavenson, of London, has established a method and constructed his own instrument; a citation from his work* will therefore be in place here:

"For this purpose I have had some electrodes made after the manner of those used for the electrolysis of stricture, but instead of the ends being made entirely of metal, I have had them of ivory, with phalanges of metal embedded in one side, so that the metal would be on the convex surface of the ends of the electrodes. By this means, we insure that when the electrode has been passed along the urethra, the metal phalanges shall come in contact with the prostatic bar or obstructing hypertrophical part of the prostate. The electrode is connected with the negative pole of the battery, the positive pole being placed on some indifferent part of the body. The circuit is then closed and a weak current of 5 milliamperes is employed. By this means, a furrow, or groove, is made on the surface of the enlarged prostate by the action of the current. The result has been such as to encourage the hope that this may prove a very useful form of treatment. The operation should not be prolonged for more than 20 minutes, and on the first few occasions for about half that time, unless the electrode passes into the bladder sooner. Should this be the case, I would advise that all further attempts be suspended for at least a week, and then repeated if no indication to the contrary has arisen."

184. Electrolysis by Strong Currents.—While others have used stronger currents, Dr. G. Betton Massey, of

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*"Electrolysis in Surgery,' London, 1890, page 106.

Philadelphia, has very recently begun a new treatment of hypertrophy of the prostate gland. He calls it the "swelling method." With the electrodes in place, the active electrode within the urethra or rectum and the indifferent on the abdomen, the galvanic current is turned on by means of his controller until a decided sensation is produced or the meter shows a desirable dose, and is turned off again in a few seconds, the procedure being repeated eight or ten times. He uses as much as 70 milliamperes, though each case must be a rule to itself in this particular. As the growth diminishes, the sensitiveness of the prostatic urethra will increase until finally from 5 to 15 milliamperes will be the limit. The negative pole has been used as the active. He makes his own instruments. After each galvanic application to the prostatic urethra, the instrument should be left in place, and a primary faradic current turned on in a swelling manner. The instrument is now withdrawn and a similar application made to the exterior of the prostate by an olive-tipped electrode in the rectum, and the same electrode on the abdomen. The rectal treatment may be employed daily, and is at times efficient, but the urethral method must be used at intervals of from 4 to 7 days only. Doctor Massey reports complete cures. This method is of such recent origin that no comment can be made on it.

185. Electropuncture.—Instead of the negative metal bulb, in this mode of treatment, a needle is used and thrust into the prostate per rectum. The best needle is made of platinum, insulated to within a short distance of its point. An electrode placed on the abdomen, to close the circuit, is connected with the positive pole of the galvanic battery. Biedert, of Hanan, reported five cases in which the hypertrophy was reduced. Leopold Casper, in 1888, read a paper before the Berlin Medical Society and claimed improvement in four cases. He uses the negative needle to the hypertrophy per rectum. He claims that the method is curative and, if carefully executed, harmless.

STATIC APPLICATIONS

186. Wave-Current of the Static Machine.—Very recently the wave-current has been used to the prostate per rectum, with a bulb or an instrument constructed for this purpose. The patient must hold the electrode himself. We have tried the method with different instruments, sometimes using a bulb in the rectum, at other times a sound at the prostate per urethram. This method has been practiced very recently and only in a few cases, so that no definite report of its utility can be made.

CATAPHORESIS

187. Cataphoresis, introducing iodin into the hypertrophied prostate, has been practiced and advised by Dr. C. S. Neiswanger, of Chicago. His lecture was read before the Illinois Medical College, January 26, 1900, and published in the Alkaloidal Clinic, March, 1900, from which is quoted as follows:

FIG. 38

Prostatic Electrode for Cataphoresis

"My method of the cataphoric application of iodin to the enlarged gland is not only rational but gives promise of better success than any of the methods heretofore used, and is so simple and safe that it may be employed by practitioners far removed from medical centers."

The applicator shown in Fig. 38 is composed of a hard-rubber tube, closed at the distal end by a hard-rubber plug. For a distance of about 2 inches from the distal end, a number of small holes are drilled. The metal inside (which is removable) consists of a copper wire twisted upon itself, on the proximal end of which is soldered a receptacle for the cord-tip.

Upon about 2 inches of the end of the twisted wire a little absorbent cotton is wound, and, after being dipped into a solution of potassium iodid (30 grains to an ounce), is inserted into the hard-rubber tube. The electrode is then attached to the

negative cord from the battery and inserted into the prostatic urethra. A large pad is now attached to the cord from the positive pole of a galvanic battery, and placed upon the abdomen of the patient, when a current of from 6 to 10 milliamperes is turned on by means of a rheostat; and this may be maintained for 10 minutes without discomfort to the patient. The treatment should not be repeated oftener than once in 5 days.

A granular or irritable condition of the prostatic urethra contraindicates both the application of the negative pole and the iodin, and as this condition often exists, it should be treated by a different method as follows: Take an electrode such as is shown in Fig. 39, which consists of a copper staff insulated with hard rubber to within 2 inches of the distal end. This is introduced so that the metal portion comes in contact with the prostatic urethra only; it is then attached to the positive pole and a current-strength of 5 milliamperes used for about 6 minutes, rotating or gently moving the electrode backwards or

FIG. 39

Prostatic Electrode for Cupric Cataphoresis

forwards to prevent it sticking to the mucous membrane. The treatment may be given every fourth day.

Much conflicting literature has appeared upon the subject of cataphoresis, but as we have given our views upon this process in detail from a physical standpoint, we deem it only necessary to say here that in the above technique the solution of potassium iodid is decomposed by the current, and the iodin, being an electronegative element, has an affinity for the positive pole; therefore, the solution must be applied from the negative pole if we would utilize the resolvent effects of the iodin in the enlarged gland. The negative being the decomposing and liquefying pole, we have, therefore, both the polar effects of the current and the iodin, each of which is indicated.

The treatment of prostatic hypertrophy has changed from one extreme to the other. In former years, the patient was

condemned to use the catheter for a lifetime, which was a very indefinite period, and it generally increased the trouble. At present the condition may be attacked surgically by way of the urethra, perineum, rectum, or suprapubically. Electrical treatment has been described here in nine different methods. All will do good, are rational, and it is for the attending physician to select the right method in its right place.

IMPOTENCE

188. The normal generative act in the male includes two parts: (*a*) copulation, which depends on a perfect erection of the penis, and (*b*) ejaculation of fertile semen into the vagina. Sterility does not include impotence, and is often met with in those who are vigorous in intercourse. Sterility is the inability to get children. Impotence and sterility sometimes run very closely together, yet, as a rule, a distinction should be made between them.* If erection is wanting, there can be no ejaculation of semen into the vagina, the patient is therefore impotent and sterile also.

189. In endeavoring to assign electricity its proper place in the treatment of these conditions, we shall be guided by the results obtained by those who have devoted special attention to these subjects and also by the results obtained in our own practice.

Prof. S. W. Gross† classified impotence as (1) *atonic*, (2) *psychical*, (3) *symptomatic*, (4) *organic*. Atonic impotence is due to diminished or abolished reflex excitability of the genitospinal center; and psychical impotence, to some derangement of the brain inhibiting the action of that center. Organic impotence depends on congenital or acquired defects of the genital organs. Symptomatic impotence is brought on by the prolonged use of certain drugs, bromids, opiates, and by various acute and chronic diseases.

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*Jacobson, "Diseases of the Male Organs of Generation."

†Gross, "Disorders of Male Sexual Organs."

Gross further divided atonic impotence into the following classes: (1) The erection is imperfect and of short duration, and ejaculation is frequently too precipitate, but sexual desire remains and intercourse is possible although incomplete. (2) The erection is either so feeble that intromission is impossible or it is entirely absent. As in the preceding variety, desire is present. (3) Here there is not only loss of power, but desire is also completely abolished.

In a study of 153 cases of impotence, the same author found that 149 cases were of the atonic variety, 1 was psychical, 1 was symptomatic, and 2 were organic. Of these 149 cases of atonic impotence, 137 were due to, or maintained by, hyperesthesia and chronic inflammation of the prostatic urethra, with diminution of the reflex excitability of the genitospinal center, and in the remaining 12 there was diminished or abolished reflex excitability of the genitospinal center without any prostatic lesion. Of the 137 cases due to, or maintained by, hyperesthesia and chronic inflammation of the prostatic urethra, 127 were of the atonic variety, characterized by feeble erection and premature ejaculation.

By far the largest number of cases of impotence must therefore be classed in the first subdivision of atonic impotence. There are more cases of atonic impotence with feeble erection and premature ejaculation than of impotence from all other causes combined. In 127 cases out of 153, there was diminished or abolished reflex excitability of the genitospinal center due to, or maintained by, hyperesthesia and chronic inflammation of the prostatic urethra. The necessity, therefore, of examining the urethra in all cases of impotence is imperative.

According to Professor Gross, the etiological factors in this pathological condition are masturbation, sexual excesses, and gonorrhea.

The effects produced by these etiological factors are frequently maintained by the existence of one or more strictures. A rational system of therapeutics is based on a correct understanding of pathology. A correct understanding of the pathology of any function implies a correct knowledge of its

physiology. We shall therefore state briefly the essential facts of the physiology of erection.

190. Physiology of Erection.—Eckhard* demonstrated that rigidity in erection was due to an increased supply of blood to the penis. Lovén† further demonstrated that increased supply of blood was due to an active dilatation of the arterioles of the cavernous and spongy bodies, and not by a constriction of the veins producing passive congestion as had been formerly taught. Venous congestion has an undoubted effect in maintaining erection, but it is not the active agent. The teaching of Lovén is important to remember, particularly at the present time when litigation of the dorsal vein of the penis is an operation somewhat in vogue in the treatment of impotence.

The nerves concerned in the act of erection arise by two roots at the sacral plexus, from the second, third, and fourth sacral nerves. They are known as the erigent nerves, and, when stimulated by an electric current, erection and ejaculation are produced, while their division renders erection and emission impossible.

Eckhard, in experimenting on dogs, produced erection by stimulating the lumbar cord, the cervical cord, and also the pons and crura cerebri. From these experiments he concluded that the fibers of the erigent nerves, the electric stimulation of which caused erection, came from the cerebrum and passed down through the crura and pons to the cord. Goltz‡ proved that after dividing the cord above the lumbar region, irritation of the glans penis produced a full erection. He therefore demonstrated the existence of an independent reflex center in the lumbar region of the cord.

The erigent nerves not only contain fibers, the stimulation of which produce erection, but also fibers coming from the brain, which convey inhibitory impulses preventing erection. The inhibiting action of the brain on the reflex center in the lumbar cord was also demonstrated by Goltz.

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*Beiträge zur Anat. und Phys., Bd. III, page 125 and Bd. VII, page 67.

†Arbeiten aus der Phys., Anstalt zur Leipzig, 1866, page i.

‡Pflüger's Archive, Bd. VIII, page 460.

To recapitulate, there are three centers governing erection: (1) Nerve-centers in cerebrum (psychical); (2) an independent reflex center in the lumbar division cf the cord; (3) the peripheral nerves.

It is important to remember that the mechanism of erection is not merely a retention of venous blood, but an afflux of arterial blood into the elastic erectile tissues of the penis. This mechanism, however, cannot take place by itself and is induced and governed by the power of the nervous system as explained above. This knowledge is of the greatest importance in making a correct diagnosis and in instituting and carrying out an intelligent plan of treatment. We have devoted these few pages to the pathology of impotence and the physiology of erection, in order to describe the treatment of impotence in a rational manner.

ELECTRICAL TREATMENT

191. There is no electric modality that has not been tried in the treatment of impotence, and, according to Larat,* all modalities have given some good results among many failures. This author believes in the psychical action of electric currents in the treatment of impotence. Accordingly, he tries one modality after the other and perseveres with the one that seems to do the most good. In the treatment of 20 cases, which he does not classify, Larat obtained 30 per cent. of cures. Lewandowski† dismisses the subject of impotence in less than one page, and recommends the negative pole of the direct current intra-urethral and also externally to the perineum, scrotum, and penis, the positive pole being placed on the lumbosacral region. In symptomatic impotence, he claims very excellent results for this line of treatment.

192. Erb‡ states that the majority of cases of impotence require direct electrical treatment of the genitals, and this may constitute the main feature of the treatment if the sexual dis-

*Larat, "Traite Practique D'Électricité Médicale."

†Lewandowski, "Elektrodiagnostik und Elektrotherapie."

‡Erb, "Handbook of Electrotherapeutics."

order is the sole or predominant symptom. Erb recommends the galvanic current as follows:

"The anode (large electrode) is placed on the lumbar cord, and the cathode (medium electrode), stabile and labile, along the seminal canal from the inguinal ring downward, for 1 or 2 minutes on each side; the current should be tolerably strong, so that a distinct burning sensation is produced in the integument. This is followed by a vigorous labile application of the cathode (1 minute) to the upper and lower surfaces of the penis as far as the glans; finally the cathode may be applied labile and stabile upon the perineum as far forward as the root of the penis (1 to 2 minutes); a few interruptions or changes of polarity may be made, in order to secure more active stimulation. If the penis, especially the glans, is anesthetic, the cathode may be applied in this position for a longer period. If the testicles are atrophic, flaccid, and the scrotum cool, the current may be passed directly through them."

In severe and obstinate cases, Erb applies the direct current to the lumbar divisions of the cord. The treatment must be continued for a long time, at least 6 to 8 weeks (daily sittings), and often much longer. These electrical applications may be combined profitably with other measures of treatment. The treatment was generally carried out by Erb with very satisfactory results in cases of impotence of the atonic type.

These cases were characterized by the so-called "irritable weakness" of the sexual function, with feeble erections and premature ejaculations, abnormally frequent nocturnal pollutions, leading, finally, to daily pollutions and spermatorrhea. These conditions were accompanied by symptoms of neurasthenia and particularly by marked hypochondriac depression.

193. Arthuis* used static methods in the treatment of impotence. His treatment consisted in the application of frictions and sparks to the lumbar spine and to the perineum. For the neurasthenic symptoms of impotence, he used general static methods with localization to head and upper cervical spine. In organic impotence due to congenital or acquired malformation

*Arthuis, "Électricité Statique."

or injuries, electric currents are of no service. Where the impotence is due to disease, electric currents are valuable agents in restoring tone to the genital system and in correcting defective states of local nutrition. The thickening and induration that remains after gonorrheal epididymitis may be decidedly benefited by the judicious local application of negative galvanism.

194. There occur cases of impotence in young men who are well developed and strong with the exception of the penis and testicles. They have never had any decided sexual inclination; their penis and testicles are somewhat shrunken and anesthetic. These patients have a tendency to hypochondria. When erections do occur they are incomplete and are not of sufficient duration to permit coition. The electrocutaneous sensibility of the penis and particularly the glans is considerably diminished. In these cases the faradic brush applied to the testicles, to the upper and lower surfaces of the penis, and also to the glans penis, gives excellent results.* The application of the faradic brush causes the skin to become red and warm, the penis appears less shrunken, and occasionally during the application an erection takes place. Usually, however, an erection occurs some hours after the application. About twenty or thirty applications are required to effect a cure. In the congenitally abnormally small penis and testicle, the results of the applications of the faradic brush are surprising. In the majority of cases, the evidence of increased development is manifest after 2 or 3 weeks' treatment. Atonic and psychical impotence are frequently difficult to differentiate. In this regard the following words of Sir J. Paget will be found useful: "If a man has sexual organs, including the prostate, not manifestly diseased or wasted, and has erections and occasional nocturnal emissions and any sexual desire, you may be sure that he is not impotent unless he has very clear facts to prove that he is. The statements that hypochondriacs make to show that they are or are becoming impotent are usually evidence that they are not."

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*Erdmann, "Die Anwendung der Electricität in der Praktischen Medicin."

195. Of 153 cases of impotence studied by Gross, 127 were of the atonic variety, characterized by feeble erection, premature ejaculation, and due to or maintained by hyperesthesia and chronic inflammation of the prostatic urethra. The treatment of this variety of atonic impotence is of the greatest importance, owing to its frequency. Gross did valuable work in pointing out the pathology of this condition and the treatment inaugurated by him is, on the whole, good. His treatment consisted in the regular passage of steel bougies, with the internal administration of bromids, gelsemium, etc. The application of the wave-current, as recommended by Doctor Snow, or the sinusoidal current with one electrode in the rectum and pressed against the prostate, are rapid and efficient means of overcoming the hyperesthesia and inflammation of the prostatic urethra, and at the same time they tone up the exhausted genital center in the lumbar division of the cord particularly when the external electrode is placed over the lumbar division of the cord. Masturbation is the most frequent cause of atonic impotence, and, as masturbators are inclined to regard impotence as the heritage of their vice, the general tonic effects of the wave-current and sinusoidal current are rigorously indicated. The local application of the sinusoidal current to the prostatic urethra per rectum may be advantageously alternated with the sinusoidal bath, or the bath with four cells. The victims of atonic impotence frequently complain of a long list of symptoms, but the majority of the symptoms will be rationally treated by the proper application of one or more of the electric currents now used in medicine and surgery.

196. When the hyperesthesia of the prostatic urethra is reduced by the application of the wave-current or sinusoidal current per rectum, or by the regular passage of steel bougies, negative galvanism (3 to 4 milliamperes) may be directly applied per urethra to tone the structures of the prostatic urethra and ejaculatory ducts. In many cases, the entire spinal cord and particularly the lumbar division, will require applications of the galvanic current in the following manner: An electrode (5 in. × 7 in.) is placed on the cervicodorsal

region and another electrode (8 in. × 12 in.) is placed on the lumbar region. The cervicodorsal electrode is made positive. From 30 to 40 milliamperes are passed for 10 minutes three times weekly.

The causes underlying and maintaining atonic impotence must be located and removed, or all plans of treatment will be of no avail. A tight or redundant prepuce should receive surgical attention; strictures, so frequently encountered in atonic impotence, should be treated according to directions given in the treatment of strictures; and any source of irritation to the glans penis, as accumulation of secretion or herpes, should receive attention.

Physics of Light and Cautery

Physics of Light and Cautery

EXAMINATION QUESTIONS

(1) Into what forms may the energy of an electric current be changed while passing through a circuit?

(2) What difference is there between the molecules of different substances with regard to the quantity of heat required to heat them to the same temperature?

(3) What influence has the individual weight of a molecule on the number of molecules required to make up a certain mass?

(4) If a certain mass contains a great number of molecules, how will this influence the amount of heat necessary to raise it to a given temperature?

(5) How does the specific gravity of a substance affect the amount of heat that it will take up before it has attained a given temperature?

(6) What is meant by the *specific heat* of a substance?

(7) What is understood by a *calorie?*

(8) If it requires 60 calories to raise the temperature of a platinum wire 10° C., how many calories does it take to produce an equal rise in the temperature of a piece of copper wire of the same weight?

(9) (*a*) If a current of 10 volts and 5 amperes passes through a conductor, how many calories per second are developed in it? (*b*) How many foot-pounds per second will these calories represent?

(10) A current of 8 amperes passes through a resistance of 2 ohms for 1 minute. How many calories have been developed?

(11) If a conductor first transmits a current of 4 amperes and later on a current of 8 amperes, how many more calories are developed in the latter case?

(12) When the heat developed in one part of a conductor is leaking along the conductor to other parts, by what means does this loss take place?

(13) If the small incandescent lamp of a cystoscope inserted in a cavity of the body heats the surrounding walls, by what means, in this instance, is the heat transmitted to said walls?

(14) How does a resistance-coil of iron or copper heat the surrounding air?

(15) When an electric current is passing continuously through a conductor and constantly transforms part of its energy into heat, what limits, in general, the final temperature that the conductor is able to attain?

(16) A copper conductor having an initial resistance of 120 ohms has its temperature raised 80° C. What increase in resistance has taken place?

(17) If it is desirable to use a conductor whose resistance is unaffected by changes in its temperature, what material would be suitable for such conductor?

(18) If a carbon rod has a resistance of 5,000 ohms, and its conductivity is increased at the rate of .03 per cent. per degree centigrade, what will be the resistance when its temperature is raised 70° C.?

(19) Some salt is added to a vessel of water whereby its resistance is reduced to 500 ohms. Supposing that it suffers a decrease in resistance of .6 per cent. per degree centigrade increase in temperature, what will be its resistance when the temperature of the solution has risen 40° C.?

(20) If part of an electric circuit is heated, has this part any effect on the remaining part of the circuit, as regards current-strength and temperature? Give reasons.

(21) Part of a heated conductor is suddenly dipped into cold water. What effect has this on the total resistance of the circuit? Does it affect the temperature of the parts not submerged?

(22) What important adjunct should there be in every cautery circuit to insure a constant temperature of the cautery?

(23) If a great number of watts should be dissipated in the form of heat in an electric circuit of low resistance, what other factor must be increased to obtain a sufficient quantity of heat?

(24) If the resistance of a cautery is very low, why is it that the resistance of other parts of the cautery circuit must be still lower?

(25) Is there any objection to having a cautery circuit with a resistance just low enough to give sufficient current to the cautery and with only a small adjustable resistance in the circuit? Give reasons.

(26) What should be the properties of voltaic cells used for cauteries?

(27) A cautery circuit, in which the joint resistance of the cautery and conductors is .04 ohm, is operated by three cells in parallel, each having a resistance of .03 ohm and an E. M. F. of .7 volt. What will be the current-strength in the circuit?

(28) What would be the current-strength if the same cells were arranged in series?

(29) What objection is there to using a direct current from a lighting circuit for cautery purposes?

(30) Mention a method by means of which a direct lighting current may be used economically for cauteries.

(31) Why is the cautery transformer, illustrated in Fig. 5, not as efficient as some other forms where the coils are imbedded in laminated iron?

(32) What precaution should be taken when using a cautery-snare to prevent the overheating of the platinum wire?

(33) A certain incandescent lamp requires 4 watts per candlepower. If the total candlepower is 8 and the voltage 10, what current-strength is required to operate the lamp?

Electricity in Diseases of the Eye, Ear, Nose, and Throat

Electricity in Diseases of the Eye, Ear, Nose, and Throat.

EXAMINATION QUESTIONS.

(1) In what portions of the auditory apparatus does electrotherapeutics find its chief utility?

(2) Why is the cathode of the direct current made the active electrode in the treatment of abnormal dryness of the external auditory canal?

(3) In stenosis of the external auditory canal, what is the indication for (*a*) cathodal electrolysis? (*b*) anodal electrolysis?

(4) State the indications for static sparks in diseases of the middle ear.

(5) Describe the electrotherapeutic treatment of tinnitus aurium when due to an abnormally dry condition of the nasopharynx.

(6) Describe the electrotherapeutic treatment of chronic rhinitis.

(7) What are the complications that occasionally follow this treatment, and what should be done to prevent them?

(8) What is the object aimed at in the treatment of hypertrophic catarrh, and how is this object best accomplished?

(9) Describe the electrotherapeutic treatment of hypertrophies located (*a*) anteriorly; (*b*) posteriorly.

(10) Describe the electrolytic treatment of hypertrophied masses.

(11) How would you treat ulcers found beneath crusts in simple atrophic catarrh?

(12) Describe the technique of cupric electrolysis in the treatment of ozena.

(13) Of what service is the electrocautery in the treatment of hay-fever?

(14) When malignant disease of the nasal cavities has reached a stage where radical measures are impracticable or are declined by the patient, what two resources has the operator still at his command?

(15) What two methods are recommended for the removal of nasal polypi?

(16) How is the cautery-snare adapted to a sessile growth?

(17) How is the danger of hemorrhage obviated in removing sessile growths by the electrocautery-snare?

(18) (*a*) What agent affords the most favorable results in the treatment of septal spurs? (*b*) Describe the technique of its application.

(19) Describe the electrotherapeutic treatment of epistaxis when due to ulceration?

(20) What are the essentials of treatment in clergyman's sore throat, and how are these best brought about?

(21) What effect has the age of a patient on the details of the operation for removing hypertrophied tonsils, and what method of operating is recommended (*a*) in young children? (*b*) in adults?

(22) Describe the electrotherapeutic treatment of chronic follicular tonsillitis.

(23) Describe the method of Bordier for treating stricture of the Eustachian tube.

(24) What are the objections to the use of the cautery in diseases of the larynx?

(25) (*a*) Describe the technique of cupric cataphoresis in tuberculosis of the larynx. (*b*) State its advantages over the cautery, curette, and electrolysis.

(26) (*a*) State the uses of the electrocautery in diseases of the larynx. (*b*) Give the technique of its application in these conditions.

(27) What constitutes the best treatment of stenosis of the larynx?

(28) What should be the composition of electrolytic needles?

(29) Describe the method of removing offending hairs in trichiasis.

(30) In electrolyzing a rodent ulcer, state (*a*) the pole used; (*b*) current-intensity; (*c*) duration of current-flow; (*d*) place of insertion of electrolytic needle.

(31) In treating chalazion, (*a*) which pole is made active? (*b*) what current-strength is employed? (*c*) what is the duration of current-flow? and (*d*) how often is the treatment repeated?

(32) Describe the process of electrolyzing vascular nævi of the lids.

(33) Describe the use of the electrocautery in entropion and ectropion.

(34) Which do you consider the most valuable of all therapeutic agents in the treatment of lacrimal stenosis?

(35) Describe the technique of the operation for lacrimal stenosis.

(36) (*a*) What should be the aim of treatment in chronic trachoma? (*b*) How is this best accomplished? (*c*) Which polarity is employed?

(37) Describe the method of electrolyzing pterygium.

(38) What may be said of the use of the electrocautery in phlyctenular keratitis?

(39) State the advantages of galvanism in the treatment of opacities of the cornea.

(40) Of what service is the electrocautery in the treatment of keratoconus?

(41) Describe the process of removing powder grains from the conjunctiva, cornea, or eyelids by means of the electrocautery.

(42) What is the chief use of electric currents in the treatment of inflammatory affections of the ciliary body and iris?

(43) (*a*) Of what service is galvanism in glaucoma? State (*b*) the current-strength used and (*c*) the duration of current-flow.

(44) Is electrodiagnosis employed in ocular paralysis?

(45) Describe the electrotherapeutic treatment of ocular paralysis.

Electricity in Genito-Urinary Diseases

ELECTRICITY IN GENITO-URINARY DISEASES

EXAMINATION QUESTIONS

(1) With what two currents is the major part of genito-urinary work accomplished?

(2) State the use of Newman's hydrogalvanic electrode, and the current-strength generally used.

(3) In what manner should a physician purchase electro-therapeutic apparatus?

(4) What two factors should be carefully studied in the composition of dispersing electrodes?

(5) What is recommended as a protective for the dispersing or the indifferent electrode?

(6) State the nature of the metallic bases used in indifferent electrodes in the order of their serviceability.

(7) Describe the sinusoidal apparatus of Gautier and Larat.

(8) Define (*a*) strictures; (*b*) electrolysis.

(9) What is the electric charge of (*a*) anion? (*b*) cation?

(10) What is the nature of the cicatrix produced by (*a*) the anode? (*b*) the cathode?

(11) Describe the five principal tests for the identity of each pole.

(12) How may electrolysis be made caustic in its action?

(13) What is the best apparatus for the preliminary exploration of an urethra supposed to be strictured?

(14) Describe the armamentarium necessary in the treatment of urethral stricture.

(15) Describe Newman's urethral electrodes.

(16) In what does the art of successfully applying electrolysis consist?

(17) Is it advisable to apply electrolysis on the same day that the first examination is made?

(18) What size electrode is usually selected in beginning the electrolytic treatment of stricture of the urethra?

(19) What current-strength suffices in the majority of cases of stricture?

(20) If there is more than one stricture, what is the method of procedure?

(21) Should force ever be used in the electrolytic treatment of stricture of the urethra?

(22) What is the usual length of each séance?

(23) If pain occurs during electrolytic treatment of strictures of the urethra, what does it indicate?

(24) How many instruments are passed during each séance?

(25) How often is the operation of electrolysis repeated?

(26) Is the result produced by electrolysis in the treatment of stricture due to absorption or to dilatation?

(27) What is the effect of negative galvanism on spasmodic action, and what current should be employed to overcome this condition?

(28) State the advantages of electrolysis in the treatment of urethral stricture.

(29) To what is failure in the electrolytic treatment of stricture of the urethra to be attributed?

(30) What qualifications should the operator have in order to successfully treat stricture of the urethra by electrolysis?

(31) What is the objection to anesthesia in electrolyzing a stricture?

(32) Describe Doctor Fort's operation.

(33) State the objections to internal urethrotomy.

(34) Describe the electrolytic treatment of urethritis chronica glandularis.

(35) Describe the technique of electrolytic treatment of stricture of the esophagus.

(36) State (*a*) the current-strength used, (*b*) the duration of each séance, and (*c*) when séances may be repeated, in cases of esophageal stricture.

(37) What may be said of the success of electrolysis in treating stricture of the rectum?

(38) Describe (*a*) the armamentarium necessary in the electrolytic treatment of stricture of the rectum, and (*b*) the technique of the operation.

(39) Of what service is electrolysis in malignant stricture of the rectum?

(40) Describe the electric treatment of prolapsus ani.

(41) Describe Newman's method of treating hypertrophy of the prostate with the electrocautery sound.

(42) State the important factors in Bottini's operation.

(43) How many incisions are usually made in Bottini's operation, and which incision is the most important?

(44) Under what condition is the anterior incision employed, and what is its danger?

(45) On what does the length of the incision depend?

(46) When the prostate is soft and compressible, what is the usual length of incision?

(47) Under what conditions are long incisions recommended?

(48) On what do the results of Bottini's operation for prostatic hypertrophy depend?

(49) When is it recommended that the Bottini operation be done?

(50) State the complications that may occur during Bottini's operation, and how they are best prevented.

(51) State the post-operative complications.

(52) Describe the technique of iodin cataphoresis in the treatment of hypertrophy of the prostate.

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